Circular economy of electric power smart meters

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Introduction

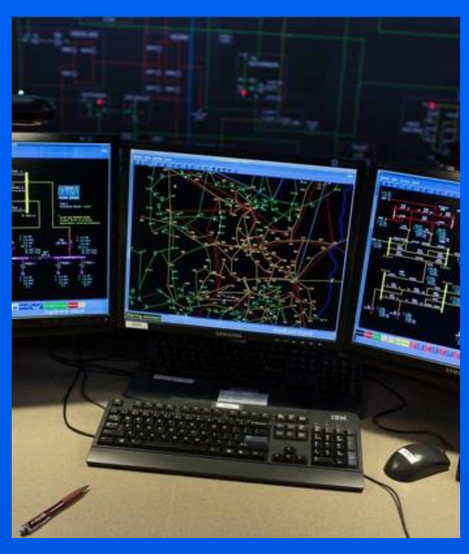

Figure 1: Energy control centre

The electricity sector has seen several changes in recent decades as a result of market liberalization. Nowadays, competitive energy markets offer sufficient electricity production, technological innovation and lower pricing. The safe functioning of electrical systems in this environment necessitates continuous monitoring of their operating conditions. This is accomplished via control centres, which gather data from different measuring equipment in order to limit and regulate power losses and avert difficulties.

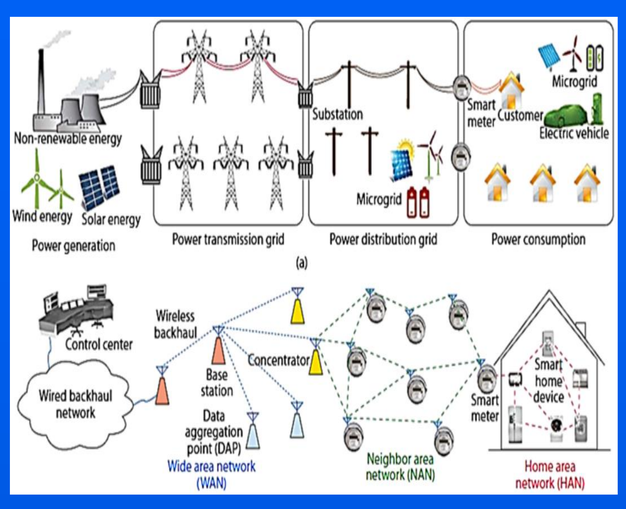

Figure 2: Smart grid

Electricity grids have progressively started to incorporate information and computer technologies, resulting in the birth of the smart grid. The smart grid is an electrical grid that offers energy to clients from several places and distributes energy using novel applications on existing transmission and distribution networks. A key device of smart grids is the smart meter. The smart meter is an enhanced energy meter that detects a consumer's energy use and gives extra information to the utility provider.

Results & Discussion

A circular economy is defined as a collection of economic activities that concentrate on decreasing long-term waste of manufacturing process resources. The basic components of public policy for the circular economy are:

- Financial instruments
- Create regulatory frameworks and rules, as well as reduce bureaucratic impediments.
- Connecting small and medium-sized enterprises (SMEs) and the social economy to technology innovation, as well as planning and implementing pilot / demonstration circular economy initiatives
- Improve governance and networking, as well as accelerate processes

The manufacturing process and the product life cycle must be examined in order to achieve circular economy at the smart grid level, with a focus on smart power meters. More specifically, five different types of smart meters to discover the average values corresponded extremely well to each specific component :

- Landis+Gyr E650
- Landis+Gyr E850
- Actaris ACE5000
- Actaris ACE 6000
- Edmi Mk10E ATLAS

Table 1: The materials/components of smart meters

Smart Meter Type	Weight (kg)	Steel (kg)	Copper (kg)	Plastic (kg)	LCD (kg)	Other (kg)
E650	1.500	0.310	0.500	0.405	0.040	0.245
E850	1.600	0.345	0.532	0.428	0.031	0.264
ACE 5000	1.700	0.390	0.591	0.422	0.036	0.261
ACE 6000	1.900	0.401	0.664	0.531	0.026	0.278
Mk10E	2.000	0.417	0.666	0.559	0.038	0.320

Note that other components include epoxies, ceramics etc.

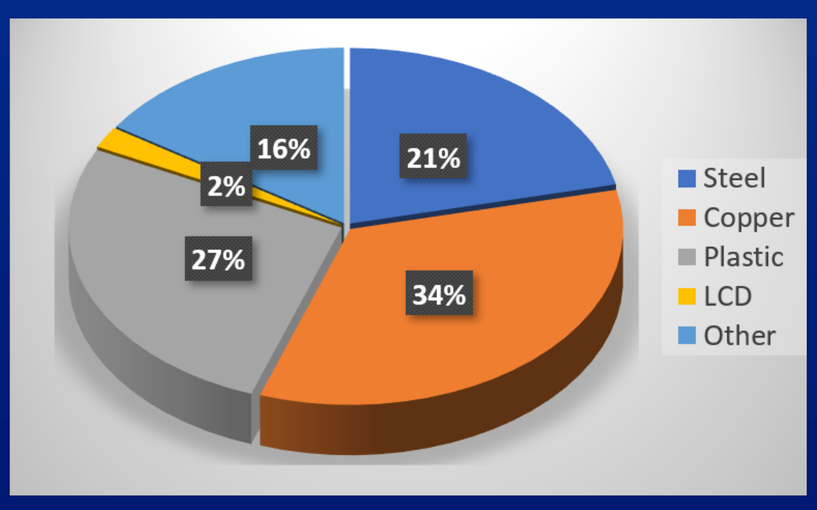

Figure 3: The five smart meters' material/component composition

Figure 3 presents the five smart meters' material/component composition given in percent of the total smart meter weight considering that the average weight of the total amount of the smart meters is equal to 1.740kg.

In order to quantify the average weight of each component in terms of materials' cost, we calculate the average cost of the components considering their corresponding market value as this provided by stock markets. Table 2 presents the average cost of each material.

Table 2: Average material cost of the five smart meters

Material	Cost (US$/t)	Average material cost
Steel	1,647.50	0.61
Copper	10,255.00	6.06
Plastic	3,562.58	1.67
LCD	250.00	0.01
Other	300.00	0.08

A "fair" smart meter is characterized as one that:

- made with the use of circular materials and fair labor methods
- operates with minimum energy consumption
- contains no harmful compounds or minerals

The most essential obstacles that must be overcome while developing the "fair" smart meter are as follows:

- working circumstances
- "conflicting minerals"
- mineral deficiency
- the dumping of minerals

Figure 4: The smart meters circular economy chain

The features of "fair" smart meter would be transferred to next-generation meters and their manufacturing, operation, and usage, as well as to the recycling procedures related with smart meters. The major goal, with a specific emphasis on circularity, was the usage of resources and raw materials throughout the lifespan of a smart meter. Circularity focuses on striving to circulate resources of both raw and used materials in order to decrease waste through reusing, refurbishing, remanufacturing, and recycling. As a result, the value that was developed from raw materials and resources is retained to the greatest extent possible.

Conclusions

Smart meter materials must be reduced, avoided, or replaced in order to build a better smart meter design and guarantee the green footprint in manufacturing and prolong the life of a smart meter within the circular economy.

At the end of life cycle, the smart meter should be recycled using a specialized procedure that involves collecting, sorting, breaking, cleaning, and drying.