LOCALISED ENERGY CONSUMPTION AGGREGATES USING SMART METER DATA

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ABSTRACT

This paper aims at leveraging the concepts and results produced in the FLEXICIENCY Horizon 2020 and their potential use by local energy authorities. Indeed, an IT collaborative place for B2B exchange services (EU Market Place) has been developed to catalyse & facilitate interactions among energy stakeholders. For instance, in the French demonstration, an aggregated data service has been implemented and successfully delivered from end to end. This paper demonstrates the ability of a data custodian (here the DSO ENEDIS) in supporting energy transition as a whole.

TOWARDS ENERGY TRANSITION

Electric systems policies are constantly moving yielding the deployment of energy efficiency measures and the penetration of clean usages such as Electric Vehicles. Recently, self-consumption has been incentivised through PVs/wind installations at residential level.
Policy makers may want to assess the impact of the different measures they put in place towards clean energy systems. In particular, some indicators may be requested to track the progress made in energy consumption behaviours either in quantities (reduction) or in profiling (flattened load curves) for instance.
Furthermore, some social indicators could be extracted crossing economic/urbanistic levels with energy consumption to better emphases between different social categories. For instance, extreme consumption can be highlighted from the highest to lowest values in a given local area to alert on energy leaks or fuel poverty, anticipating either on environmental responsibilities or social consequences.

METER DATA AGGREGATES

Aggregated data represents a quantity (sum or mean of consumption/generation) related to customer category (business/individual/installed power/tariff choice) in a given geographic area or a list of PODs (Point of Delivery). Provision of such data is still subject to customer consent and is authorised to be shared or published only in certain conditions, which is defined by law, imposing anonymization techniques. Indeed, large number of customers is needed to be merged in order to protect data privacy of the individuals within a set/category to be aggregated.

For instance on the FLEXICIENCY Market Place, Data provider has to precise whether customer consent is needed even when publishing aggregated data service.

Data Processing by Profiling

Data profiling has been being in use in France for more than 20 years, mainly for load curve modelling, contributing at the beginning to demand forecast and later on to balancing market settlements.

A representative sample of customers (randomly selected according to a sample design) participate to more accurate and regular metering about their usages. Data processing provides a load profile that reflects a form of consumption or generation. For a given customer category, these values reflect how an average customer in this category consumes or produces electricity over time, and take into account holidays and weather conditions (dynamic profiling) .
It represents the pattern (or shape) of electricity usage.
Thanks to profiling methodologies, data scientists could, without collecting all the smart meters data (a safer approach to protect data privacy of individuals), provide value data services to different stake holders especially for balancing settlement process.

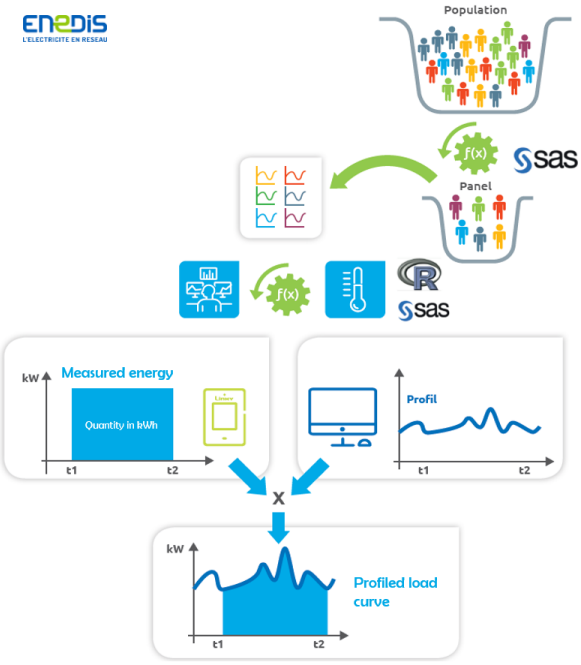

Figure 1. Load profiling process

Data Services with Smart Meters

With smart meters, the load profiling system will improve dramatically: Smart meters rollout will have benefits to consumers, energy suppliers, network operator and other market participants, and will contribute to environmental energy policy goals. Benefits are expected for market Players at two levels: by accelerating the reading rhythm and improving the profiling quality. The following figure shows recent smart meter data services/portals provided by Enedis, making available Linky smart meters data especially towards the consumer who actually owns his individual. Data.

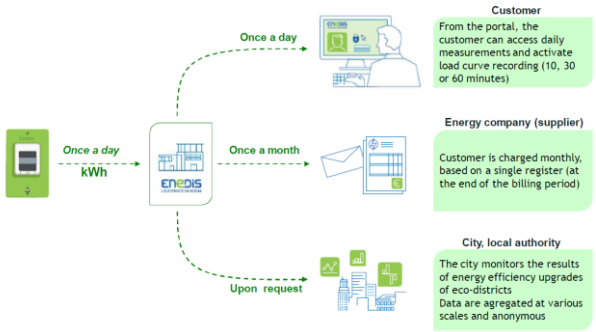

Figure 2. Linky data flows

DSO ROLE IN DATA PROVISION

To build and keep track on Clean Energy Progress, a DSO who manages smart metering infrastructure can provide different data services (see for instance enedis website for more than 30 open data sets). More precisely, localized historical consumption aggregates may suit local energy authorities as a specific service.
Indeed, as network operator and key actor in balancing markets settlements, ENEDIS developed an expertise in the processing, analysing and publishing metering data, while guaranteeing privacy, safety and security of data. Recent deployment of smart meters will enhance the data custodian role of DSOs as a whole.

Typically, some of energy transition indicators, as described above, may be misleading if not properly analysed. For instance, different autonomous external factors may influence energy consumption & generation, such as weather (temperature, wind, brightness, etc). Therefore, metering raw data are not sufficient to compare historical data to actual ones. Usually, Data analysts, in energy companies such DSOs, bring back metering data to the called referenced data: a cleaned data from any external weather impact.
Therefore, by bringing its expertise, DSOs have definitely a role to play in energy transition. For instance, in France, daily smart metering indexes are allowed to be processed per 'Region' to provide aggregates per type of customers. Some futures services based on averages, quantiles, are currently under consideration. Potential beneficiaries of specific processed information could be also multi-sites customers, local authorities, actual and potential retailers, ESCOs, aggregators, TSOs.

Such interactions may be made through FLEXICIENCY EU market Place as a contact point to be adapted and exploited in the future, using standardised meter exchange format as presented at the end of this paper.

FLEXICIENCY PROJECT

Major European DSOs are working together with market players and other stakeholders within the Horizon 2020 – LCE-07-2014 FLEXICIENCY project to develop a technical model in order to achieve a vision of data exchange based on the meter data accessibility provided by DSOs. The FLEXICIENCY project has already produced some technical results (see CIRED 2017 papers 223 & 225), mainly:

- Market Place prototype delivery (see MP webinar for videos).
- EUMED-CIM standard format for EUropean Metering Exchange Data (see D2.3 & D6.0).
- Technical guide for MP interactions & B2B Data exchange specifications.

FRENCH DEMO IMPLEMENTATION

The DSO Platform involved in the French demo implements the common standards and communication protocols required in the FLEXICIENCY system specification (see REF D2.2, D6.0, D4.2).

As shown in Figure below, this Platform acts as an exchange Platform, which interacts between:

1. Market Place prototype (FLEXICIENCY), for collaboration & contracting.
2. Smart Metering Information System (here the Linky Enedis IS), for internal data sources.
3. Internal data processing, for data aggregates generation.
4. Data transformation, for standardized data exchange delivery using EUMED CIM.
5. Expose Data in REST APIs.

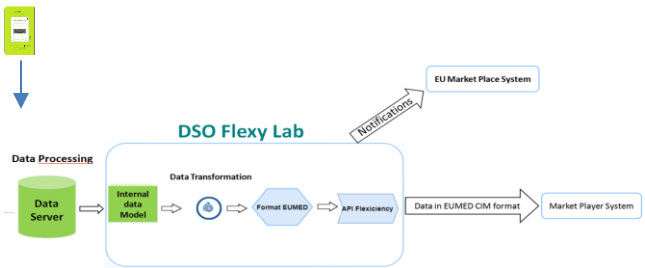

Figure 3. French demo Platforms connection

The access to the STM system (of Treatment of Metering) allowed to get Linky smart metering validated data. A platform for processed data has been developed to assess, visualize & validate the data services before delivery, as shown in the Figure below.

Figure 4. French demo Prototype for Processed data

STANDARDIZED DATA EXCHANGE

This section is devoted to a common model defined in FLEXICIENCY (see D6.0, D2.3) called European Metering Exchange Data (EUMED CIM), for which mapping and interoperability has been tested with Enedis data flows either for Individual or Aggregated data. We recap design options for exchanging time series, describe their implementation using UML model elements of CIM Metering package and discuss variants and optimizations.

Time series

Several options exist to describe time-related concepts and series.

DateTime – DateTime represents a point in time defined precisely. Sample: "2018-02-18T12:11:01Z". The standard way is to use UTC date and time using "YYY'-'MM'-'dd'T'HH':'mm':'ss'Z'" pattern. However, current practice is to use local time because it is easy to convert from local time to UTC time but the reverse is more complicated due to energy-savings regulation. Timestamps are sometimes used instead of date time because it is easy to convert in both ways and more compact.

Duration - A duration is a lap of time not constrained in time. Sample "thirty minutes". A compact way to represent duration is the W3C pattern "PnYnMnDTnHnMnS". For instance, "thirty minutes" is represented by "P0Y0M0D0H30M0S". However, this is not very human friendly. Other way is to propose a pre-defined list of duration values. Also, Date (ie. DateTime without Time) can be used to represent duration constrained in time. For instance, "2017" represents the time elapsed during last year and "2018-02-18" represents the 24 hours of today.

DateTimeInterval - A DateTimeInterval is a lap of time constrained in time. Sample: since "2018-02-18T00:00:00Z" until "2018-02-18T12:00:00Z". Usually, like for other kinds of intervals, two DateTime values are used to represent the start point and the end point of the interval. However, other ways are possible. For instance, in the Green Button standard, a duration is used instead of an end point. Also, the start point or the end point may be omitted to represent intervals opened at one extremity.

Periodicity - A periodicity is a recurrent lap of time. Sample: "daily". This form is more frequently used in selection criteria of subscription contracts than in data delivery.

Time series - A time series is a specific kind of series that is linked to time-related concepts and/or that is composed of values that are linked to time-related concepts (see "The introduction of different time series possibilities (curve type) within ENTSOE electronic documents"). The most general way to handle time series is to associate to the series a DateTimeInterval value and to each point of series a DateTimeInterval value. A time series with fixed time step is a specific kind of time series where values belonging to the series are regularly spaced. In this case, a third time-related value is given - the time step - usually expressed as a duration. Also, instead of a DateTimeInterval value, a position (rank in the series) may be associated to values composing the series. However, as a position is less precise, this solution may be used only for punctual measures or sequential interval measures.

Series of multi-values - They are special case of series containing multiple curves (multiple values at the same time). If values in the series are based on simple numerical data types, a way to handle this case is to use as many series as the maximum number of simultaneous values. Another way is to use both a DateTimeInterval and a rank to simulate an array or a sequence of values. If values in the series can be based on structured data types, each point is an array or a sequence of values.

Series of series - Series of series are used in case a series may be split into distinct periods or blocks of values. Three approaches are possible: one-level series (each period is a distinct series), two-level series (a series is composed of periods and a period is composed of points) and any-level series (a series is recursively composed of series or of points).

Empty series and missing points - In case a series is missing in a payload, this may be indicated as a series with no contained values or with the absence of the series. In case a value is missing in a series, this may be indicated as a point with no value or with the absence of the point (holes in rank values or in DateTime intervals).

Quality – Quality indicators may be used to indicate the level of confidence in the value (in case of a point) or in the whole series (in case of a series).

EUMED-CIM model

The structure of the EUMED CIM format is given in the following figure.

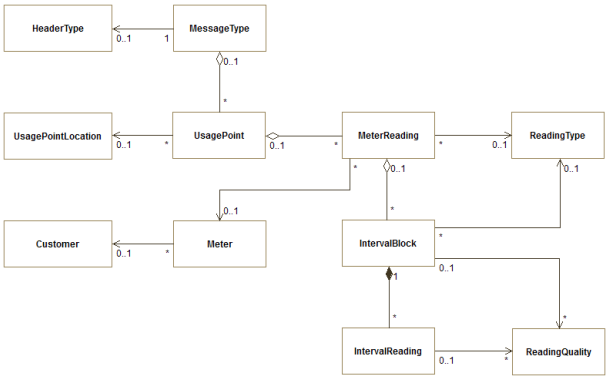

Figure 5. EUMED CIM Entities

MessageType – This entity represents the root (or the payload) of the message. It has no attributes but is characterized by administrative information contained in the Header and contains time series grouped by usage points.

HeaderType – This entity describes the structure of the header of the message. It is characterized by identification of the stakeholders (emitter and receiver of the message) concerned and date time of the exchange together with some technical and administrative information.

UsagePoint – A Usage Point is defined in CIM standard as a "logical or physical point in the network to which readings or events may be attributed". It is used here to group the time series in function of their origin. In case of aggregated data, location of the usage point may be associated (UsagePointLocation entity).

MeterReading - A Meter Reading is defined in CIM standard as a "set of values obtained from the meter". It is characterized by the time interval of measurement and other administrative information. It may associated to a meter (Meter entity) and, in case of aggregated data, to a customer category (Customer entity).

ReadingType – This entity gives some information about the type of the time series (time step, for instance) and of the measurements (unit of measurement, for insatnce).

IntervalBlock - An Interval Block is defined in CIM standard as a "time sequence of readings of the same reading type".

IntervalReading – This entity represents "data captured at regular intervals of time". It is characterized by its value and its position in the time series (either a rank in case of regular time step or a date time interval in case of isolated points).

ReadingQuality – (sic from CIM) Typically not used unless problems or unusual conditions occur (i.e., quality for each reading is assumed to be good unless stated otherwise in associated reading quality type). It can also be used with the corresponding reading quality type to indicate that the validation has been performed and succeeded.

Support tools

To support data delivery services in EUMED-CIM format, three tools have been developed in Java using JAXB technology.

- Transfo EUMED: A data processor that transforms data structured in various internal formats into EUMED formats.
- Verif EUMED: A data validator that performs various checking rules to assess that a given data is conformant to EUMED formats.
- Bench EUMED: A benchmark tool that compares various representations and scores them.

CONCLUSION

The French demo in FLEXICIENCY EU project demonstrated the ability for a DSO to interact with external actors for future energy data services provision. Data provision uses either internal or standardized formats depending on requester's choices, while assuring business continuity with existing systems and preparing future data services.

ACKNOWLEDGMENTS FLEXICIENCY project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement n° 646482.

Disclaimer: This paper reflects the FLEXICIENCY consortium view and the European Commission (or its delegated Agency INEA) is not responsible for any use that may be made of the information it contains.

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