

## **Real-Time Market Monitoring using SAS® BI Tools**

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### **Abstract**

The Department of Market Monitoring at California ISO is responsible for promoting a robust, competitive, and nondiscriminatory electric power market in California by keeping a close watch on the efficiency and effectiveness of the ancillary service, congestion management, and real-time spot markets. We monitor the potential of market participants to exercise undue market power, the behavior of market participants that is consistent with attempts to exercise market power and the market performance that results from the interaction of market structure with participant behavior. In order to perform Monitoring activities effectively, DMM collects available data, designs, and implement reporting dashboards that track key market metrics. We are using various SAS®BI tools to develop and employ metrics and analytic tools applicable to market structure, participant behavior, and market performance. This paper provides details about the effective use of various SAS BI tools to implement an automated real time market monitoring functionality.

### **Introduction**

One of the primary functions of the Department of Market Monitoring (DMM) at the California ISO is to monitor both short-term market outcomes and longer-term market trends in the spot wholesale electricity market in California. There are multiple energy and related products transacted across three temporal markets from over 1,000 locations – all of which produce prices in the centralized market clearing. As the dimension of the market structure expanded, DMM required a more automated and centralized platform to produce insightful market metrics that would both inform analysts and reduce the time they spent producing and validating monitoring metrics so that they could spend more time analyzing market outcomes and investigating market inefficiencies.

In addition to reviewing performance metrics to assess market efficiency and trends in the markets, DMM also produces quarterly and annual market performance reports, special studies of market design elements, and investigations of potentially uncompetitive market participation. These activities rely heavily on accurate market metrics derived from large data sets and complicated data transformations specific to each metric.

Creating custom reports with SAS Enterprise Guide and showing the results via stored processes in the portal is powerful functionality – especially with extremely dynamic and complex data driving the metrics. However, large volumes of stored processes displayed dynamically on a single portal page can create processing, organization, and execution challenges. Furthermore, while leveraging the code that drives the dynamic portal content for automated PDF and HTML snapshot reports adds significant benefit, it also presents execution and output porting challenges. This paper discusses the solution of leveraging various features offered by SAS BI Server to develop Real time Market Monitoring System that provides the following:

- Ability to view the results of stored process in a custom portlet where results are updated dynamically.
- Quick response of portal pages that contain 10+ stored process results with 30+ dynamic graphics.
- Ability to view and retrieve to Excel the data behind the portal metric/graph.
- Dynamically re-run stored processes using different parameters through the portal interface.
- Automatic generation of a PDF reports displaying selected portal content from the same stored processes.

All these tasks are performed while maintaining a single source of code for a given metric across output forms via Enterprise Guide projects. This improves both efficiency and consistency by leveraging single source code for

multiple types of output. This framework was developed as a business-unit led solution and has provided an innovative and flexible business-unit driven solution for monitoring wholesale electricity markets.

### Conceptual Architecture of Market Monitoring System:

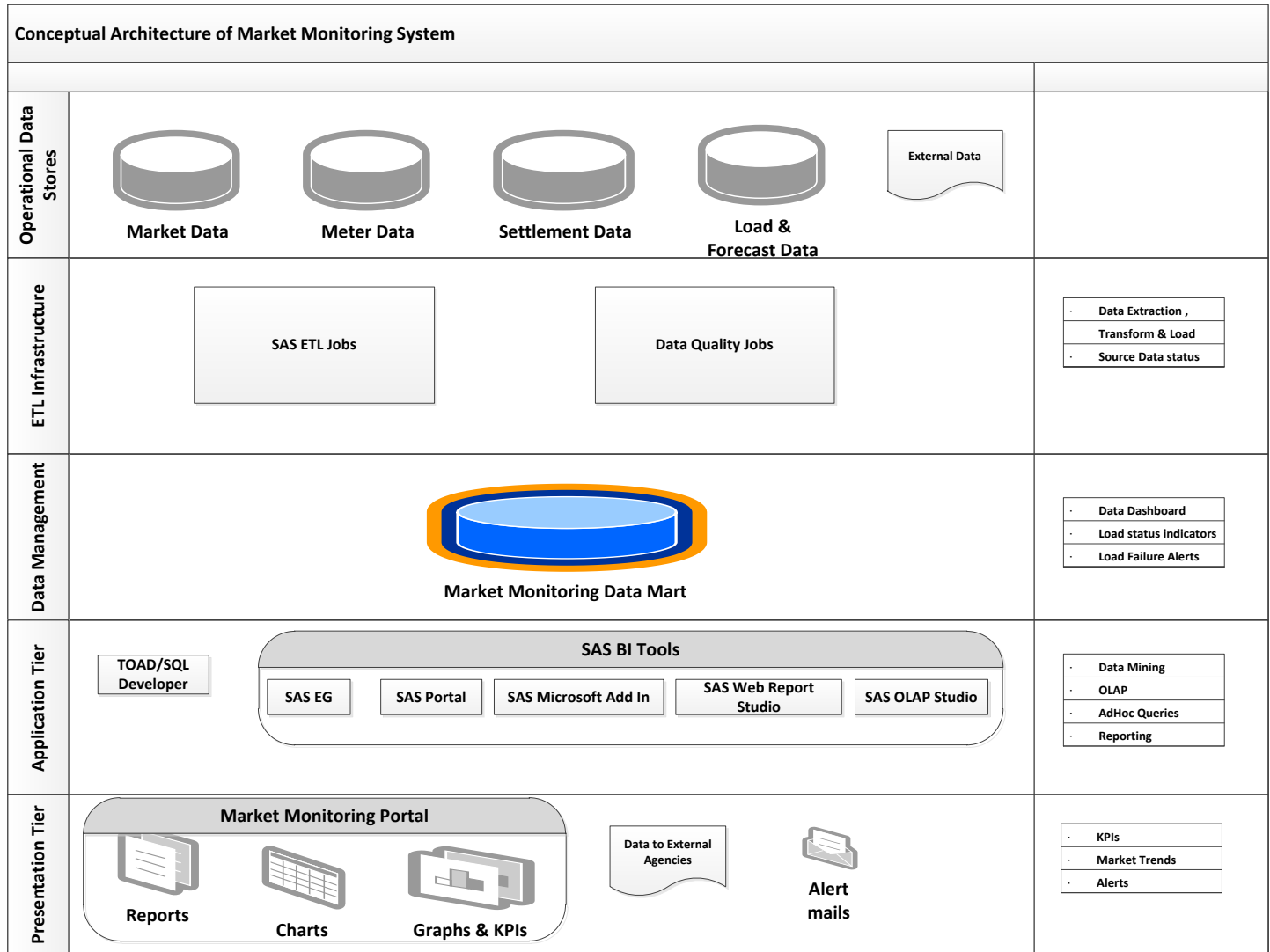


Figure 1: Market Monitoring System Architecture

### 1. Operational Data Stores:

In order to monitor market participant's behavior and overall market trends, Department of Market Monitoring uses Market data, Meter Data , Forecasting Data and some external data stored in various operational data stores. These operational Data stores contain data in different forms. (e.g. Oracle , MySQL , XML Files , Spreadsheets/csv files and raw data. ) . The main priorities of our source systems are processing performance and availability. We have used SAS BI Servers data integration capabilities to pull the data using customized ETL Jobs.

## 2. ETL Infrastructure:

As the purpose and infrastructure of Operational source systems varies, the quality and format of the data from these source systems also varies. We have utilized SAS EBI Server as our primary staging area. ETL Infrastructure consists of 2 kinds of Jobs:

### 2.1 ETL Jobs :

These hourly scheduled incremental SAS Jobs extracts data from source systems on Change Data Capture mechanism and copy it in staging area. After performing several transformations such as cleansing the data, combining and standardizing data from heterogeneous source systems data is loaded into DMM Data Mart. In order to facilitate performance management for target Data Mart, we decided to keep it on Oracle Server. This facilitates it's use by non-SAS users in different departments.

### 2.2 Data Quality Jobs :

We are dealing with different internal and external source systems and sometimes we encounter problems associated with source system data or ETL Job processing. These kinds of issues results in missing data which may cause wrong analysis in downstream applications.

In order to avoid issues in downstream analysis process and alert DMM analysts, we have designed Data quality jobs which:

- Identifies issues with source data
- Identifies ETL Job failures
- Updates Metadata of source as well as DMM Data Mart Tables
- Updates Data Mart Load status on Data Dashboard.

We have utilized Scheduling facilities provided by SAS BI environment effectively which gives us ability to not only schedule different Jobs but also establish positive and negative dependencies based on return codes upstream Jobs.

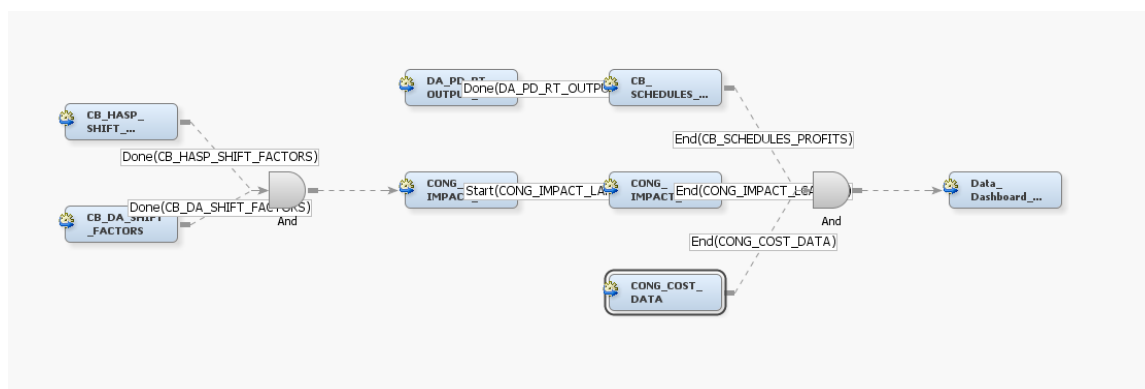


Figure 2: Scheduling various jobs with dependencies

3. Data Management:

Department of Market Monitoring uses data from DMM Data Mart for several critical reporting as well as investigation purposes. In order to ensure the quality of reports and analysis, we need to make sure that all the data is readily available. We have developed a web interactive tool which provides details about the current status of DMM Data mart and also alerts about source data issues as well as ETL Job Failures. DMM Data Dashboard helps in quick identification of data issues just in time and implementing quick fix for the problem.

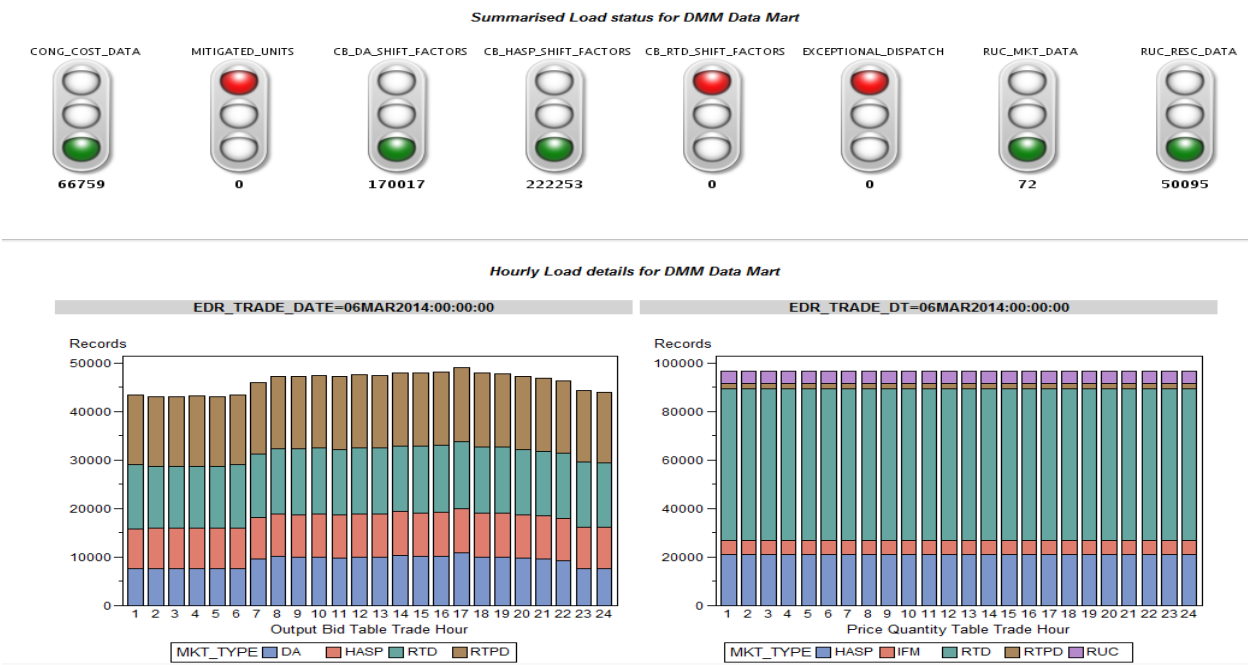


Figure 3: Data Dashboard

Dependency Finder Tool:

In order to improve market quality, CA ISO frequently releases new products or enhances existing product which involves major structural and functional changes in source systems. Whenever source table for any ETL Job or Portal Metric changes, we need to identify all downstream applications/Table impacted by given change. We have stored all dependency information in Metrics inventory table. The dependency finder tool developed using SAS Stored process Web application is used to determine Upstream as well as downstream dependencies.

Based on the information derived thru dependency finder tool, we have created a dedicated schedule flow which addresses issues with upstream source tables and re-populates all dependent tables.

4. Data Visualization and presentation:

Department of Market Monitoring developed Market Monitoring portal using SAS Stored process Web applications and customized portlets. The primary purpose of custom portlets was to publish contents (such as charts and Excel Data) generated using scheduled jobs on Market Monitoring portal. Stored process creates charts and excels files containing all the data used to generate these charts. Custom portlets are used to stream

these charts on portal. We also provided 2 buttons which provides user ability to export the underlying data into excel file and ability to execute the stored process for different time frame.

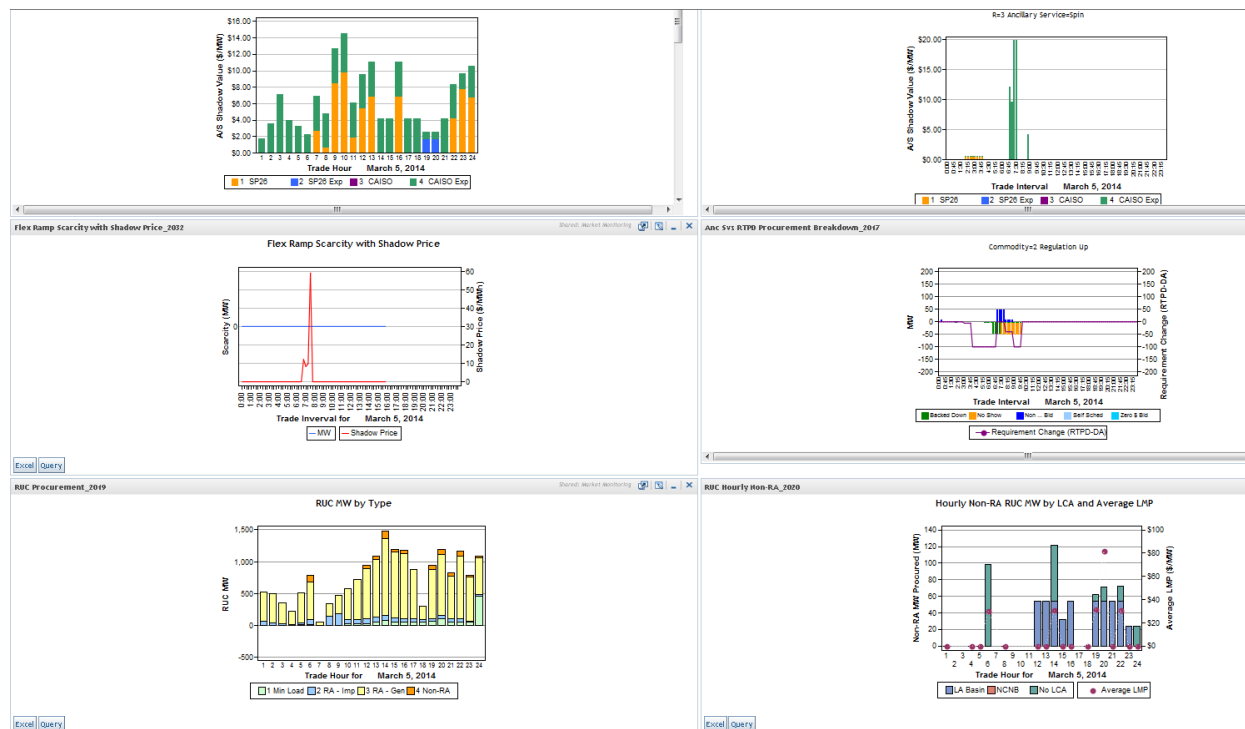
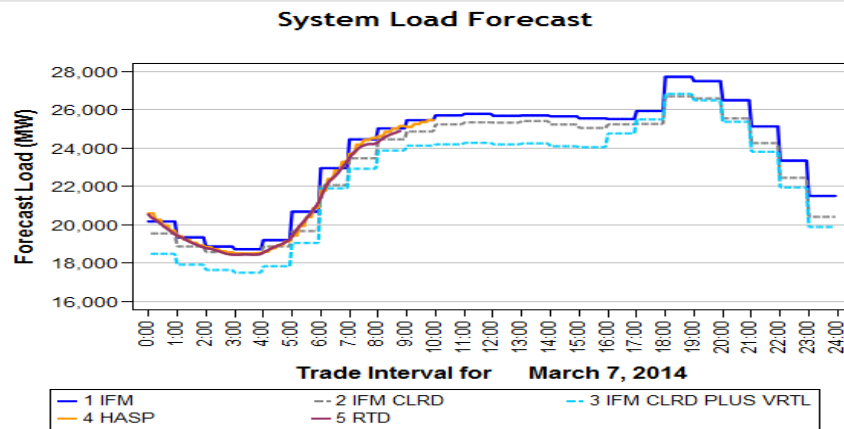


Figure 4: Market Monitoring Portal snapshot

### Interactive real-time and historical market metrics in BI portal:

The market monitoring portal contains multiple topic-specific pages that each have many market metrics (in “portlets”) that load automatically, can be run interactively with alternate parameters (e.g. dates, products, regions), and can push an Excel file containing the underlying data to the analysts computer on command. In addition to topic specific pages, we also included consolidated Daily, weekly, Monthly and annual Market state pages which contains current Market

Sometime we may need to compare real time trends with historical trends. In order to facilitate this requirement we have developed customized portlets which allows user to run underlying stored process for different time frame and produces charts for further analysis. Figure 5 , demonstrates the application of given portlet to compare results for same day from past year and current year.



Execute Stored process to  
produce chart for different day

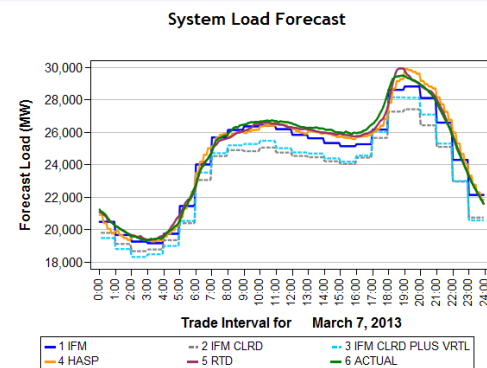
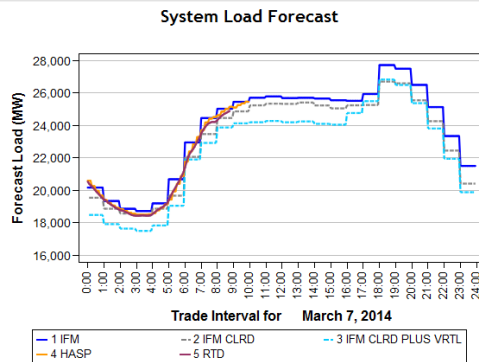


Figure 5: Real Time chart displayed on portal chart & popup chart for same day in previous year

## Historical Reports from portal content

An automated custom process collects specific metrics from the portal to create daily/Weekly reports snapshots in PDF and HTML format. These reports are stored permanently on WebDAV Server. Whenever users need consolidated Market KPIs and Dashboard for specific day, given Reports can be selected and retrieved by the user from within the BI portal rather than executing all stored process to populate the report.

Figure 6: Interactive Web application to retrieve Historical Reports

#### Features of Market Monitoring System Architecture:

- Process and enhancements for content development, function, and appearance.**  
 Process and guidelines were produced to help market analysts develop their Enterprise Guide projects such that they execute quickly, the output is dynamic and scalable, and they adhere to certain look and feel characteristics. The pre-promotion validation process ensures accuracy and the single-source for code within the BI platform ensures analysts are using the same accurate source code.
- Public Market Monitoring Portal for Non-DMM Users.**  
 Executives and other SAS users may need interactive, self-directed visual discovery and analysis but don't need real-time operational alerting. We have created unchallenged access page and added selected metrics to it which will be available for these executive users.
- Centralized single-source platform for key monitoring metrics**  
 All the Metrics are developed using SAS Enterprise Guide and then stored as a parameter driven stored process. With this approach we can use same stored code to produce results for daily, weekly and monthly reports. This forces consistency among analysts since they are all seeing the same set of metrics and, when necessary, using the same source code to build their in-depth analysis on.  
 In order to create consolidated report with specific metrics, we have used metadata functions to fetch source code of stored process of given metrics.

```
%macro prep_for_html(metapath=,name= , dev=activex, xpix=500, ypix=300);
/* Remove all work tables from previous report */
proc datasets lib=work kill nolist;
run;
/* Navigate Metadata to determine source filename of stored process */
data _null_;
length filename dirname tree dir subtree $200
uri src_uri dir_uri tree_uri subtree_uri $200;
nobj=0;
found=1;
cnt=1;
do until ( nobj < 0 );
nobj=metadata_getnobj("omsobj:ClassifierMap?@Name contains '&Name'",cnt,uri);
*put nobj= uri=;

if nobj > 0 then do;
srcRc=metadata_getnasn(Uri,"SourceCode",1,src_uri);
*put srcRc=; put;
if srcRc > 0 then do;
*put ' ***Code:' cnt= src_uri=;
rc=metadata_getnasn(Uri,"Trees",1,tree_uri);
```

```

rc=metadata_getattr(tree_uri,"Name",tree);
dirCnt=count("&metapath",'/');
*put dirCnt= tree_uri= tree=;
found=1;
do i= 1 to dirCnt;
    pos = i * (-1);
    dir =scan("&metapath",pos,"/");
    put pos= dir= tree=;
    if (tree = scan("&metapath",pos,"/") ) then do;
        rc=metadata_getnasn(tree_uri,"ParentTree",1,subtree_uri);
        rc=metadata_getattr(subtree_uri,"Name",subtree);
        tree_uri = subtree_uri;
        tree = subtree;

    end;
    else do;
        put '***** NO MATCH *****';
        found=0;
        i=dirCnt;
    end;
end; /* do=loop */
if ( found > 0) then do;
    rc=metadata_getattr(src_uri,"FileName",filename);
    rc=metadata_getnasn(src_uri,"Directories",1,dir_uri);
    rc=metadata_getattr(dir_uri,"DirectoryName",dirname);
    call symput("&spSource",trim(left(dirname)) || '/' || 
trim(left(filename)));

    put dirname= filename=;
    stop;

end;
end; /* srcRc */

end; /* nobj > 0 */
cnt+1;
end; /* do-until nobj */
run;
%PUT =====;
%PUT *** Adding &spSource To PDF Report *****;
%PUT =====;
/* read file and make a copy of the code w/o certain macro calls stripped */
filename temp "/tmp/tempDRhtml.sas" lrecl=500;
data _null_;
infile "&spSource" trunccover termstr=LF PAD ;
file temp ;
input str $500. ;
if indexw(str,'STPBEGIN','%') >0 or indexw(str,'STPEND','%') >0 or
    indexw(str,'results_location','%') >0 or indexw(str,'_sas_pushchartsizes','%') >0
    or indexw(str,'create_excel','%') >0 then do;

    *output test;
end;
else do;
    if index(str,'HEIGHT=') >0 then do;
        *putlog 'BEFORE--->' str=;
        str=TRANSTRN (str,'8pt','7pt');
        str=TRANSTRN (str,'9pt','8pt');
        str=TRANSTRN (str,'10pt','9pt');
        str=TRANSTRN (str,'12pt','10pt');
        str=tranwrd(str,'HEIGHT=8pt','HEIGHT=7pt');
        str=tranwrd(str,'HEIGHT=9pt','HEIGHT=8pt');
        str=tranwrd(str,'HEIGHT=10pt','HEIGHT=9pt');
        str=tranwrd(str,'HEIGHT=12pt','HEIGHT=10pt');
        *putlog 'AFTER--->' str=;
    end;
    *putlog '--ALL--' str=;
    put @1 str $500.;
end;
run;
filename temp;
goptions ftext="Helvetica" htext=8pt dev=&DEV xpixels=&XPIX ypixels=&YPIX;
%let PROGRAM=;
%let begin_date=&RUN_DATE;
%let end_date=&BEGIN_DATE;

```



```

%include '/tmp/tempDRhtml.sas';
%mend;

```

### Lifecycle of Metrics development:

The primary purpose of developing Market Monitoring System within department is to provide a platform to implement monitoring dashboard ideas in quick succession. Various features offered by SAS EBI Server were complementary to given purpose. With the help of custom portlets and auto call macros, any analyst can roll out his metric developed using SAS Enterprise Guide into portal. This approach also eliminated dependence on highly skilled consultants and resulted in significant saving for the organization. Below given figure describes the life cycle of a metric development in detail:

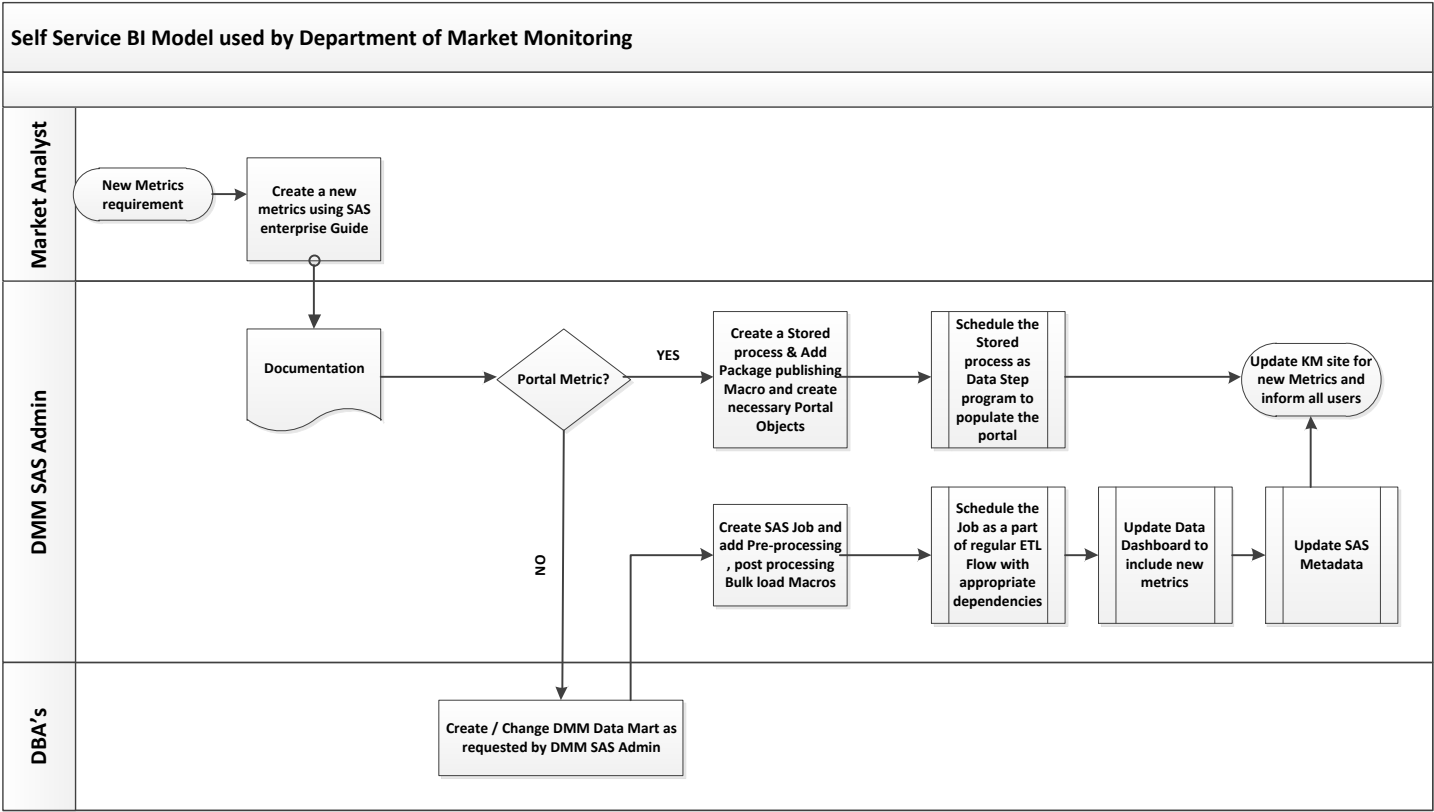


Figure 7: Self Service BI Model – Process Architecture

## Contact Information

Your comments and questions are valued and encouraged. Contact the author at:

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