

Streamlining corporate energy data analytics

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Benefits of energy data analytics

Gain Insights

- How energy is purchased and consumed
- What is causing changes in energy use over time
- What factors drive energy use
- How does current use compare to normalized baselines

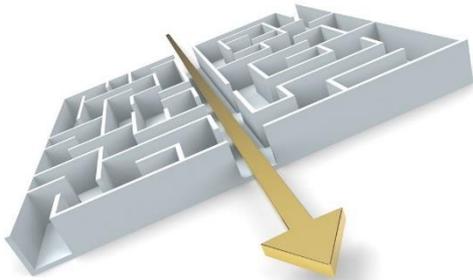
Improve Efficiency

- Increase profit
- Reduce carbon footprint
- Reduce risk

What's needed?

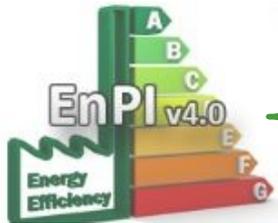
Method to:

- Gather latest data – potentially many different sources
- Store the data – potentially many sites and variables
- Analyze the data
- Provide access to results – static and interactive



- Goal:** Streamline this process as much as possible:
- Reduce effort spent on maintaining the measures
 - Increase time spent improving efficiency
 - Reduce potential for human error

Potential tools for corporate data analysis

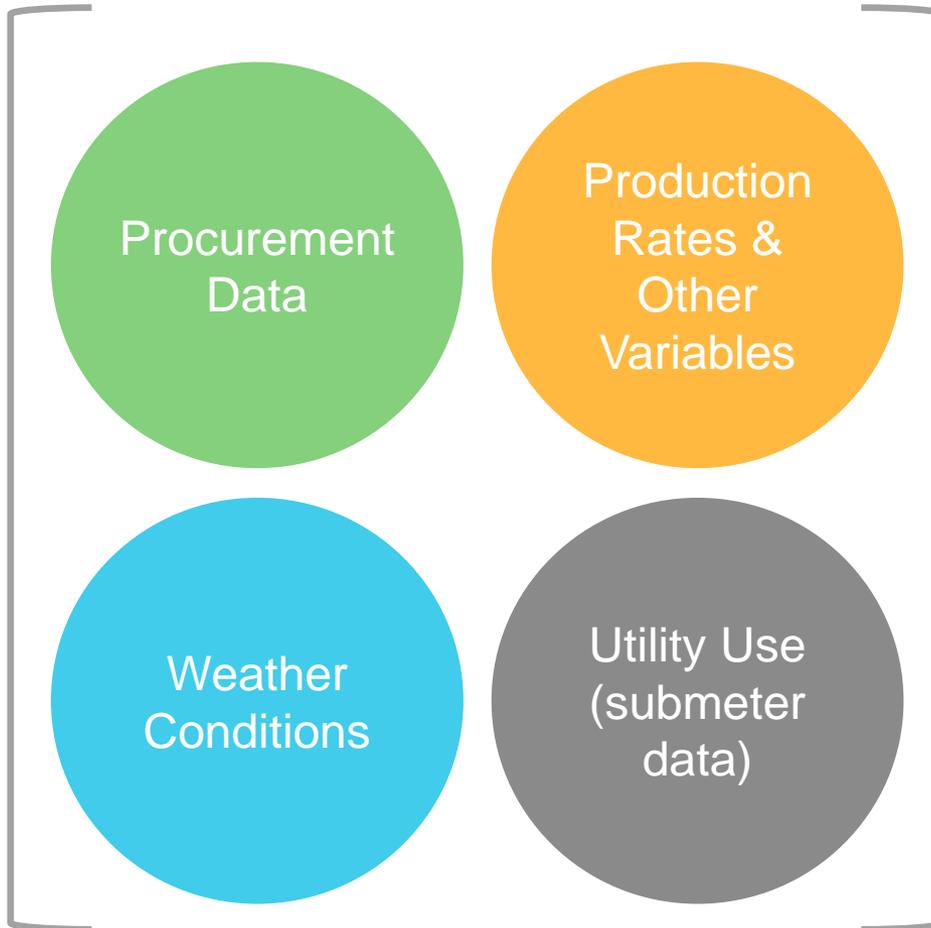


- Energy Performance Indicator
- Regression analysis based tool developed by the U.S. Department of Energy
- Capabilities
 - Store energy use and other related variables
 - Establish a normalized baseline of energy consumption
 - Track annual progress of intensity improvements, energy savings, Superior Energy Performance (SEP) EnPIs, and other EnPIs
 - Account for variations due to weather, production, etc.
 - Can be applied at many different types of facilities

EASTMAN
approach

- Largely based on EnPI methodology
- Chose to use a custom set of tools due to challenges presented by two large, integrated chemical plants

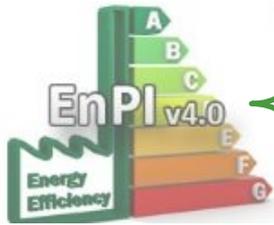
Gathering data



$$\times \quad [\# \text{ Sites}]$$

Obtaining and storing this information for many sites over time increases complexity

Gathering data

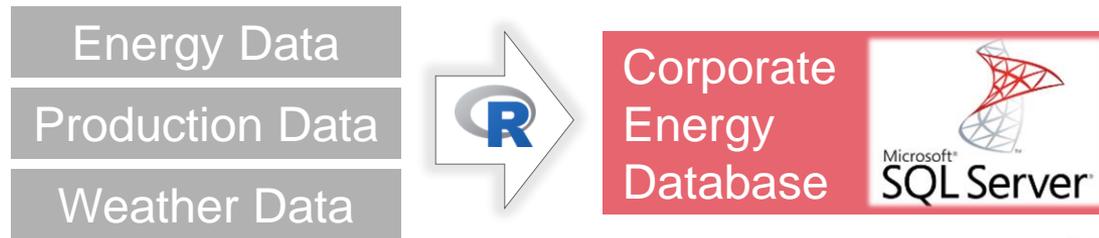


Data entered in site/area-specific Excel spreadsheets (these can be rolled-up to a corporate level)



EASTMAN
approach

- All corporate energy data is stored in SQL Server tables
- R (www.r-project.org) is one of the tools used to help automate the data collection process

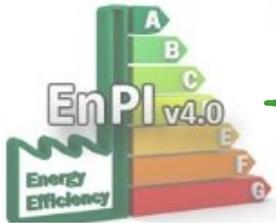


Analyzing data

Normalization helps filter out expected changes in energy use due to changes in operating conditions

- Develop models that normalize energy use to account for variation in conditions
- Include variables such as production and temperature if they are statistically significant
- Select a model for each plant / area
- Normalize raw energy data using the models

Analyzing data



- Site-specific models are developed within each Excel file to calculate normalized energy use
- Models considered appropriate if SEP (Superior Energy Performance) criteria is met
 - The model p-value is less than 0.10
 - All variable p-values are less than 0.20
 - At least one variable p-value is less than 0.10
 - The R-squared value for the model is greater than 0.50
- Default selection in EnPI is based on the model with the highest adjusted R2

EASTMAN
approach

Eastman uses R scripts to analyze data and store calculated results

Alternatives to R: Matlab,
Python, SAS, Julia, etc.



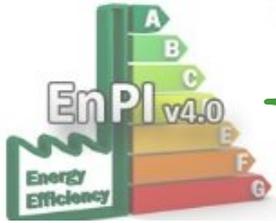
Sharing results

- Once analysis is complete, the results can be summarized and made available to others
- The results should be made available to all energy users

Benefits

- Energy users better understand their impact
- Opportunity for engagement at different levels
- More visibility tends to attract better ideas

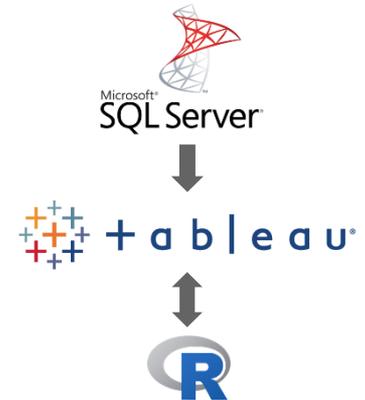
Sharing results



- Summary tables and charts show results including:
 - Actual energy use over time
 - Normalized energy use over time
 - Normalized improvement over time
- Computed for both site and corporate levels

EASTMAN
approach

- Tableau is the primary tool used to view results
- Interactive dashboards
 - Connects directly to SQL data
 - Ability to create calculated fields
 - Connects to R for advanced, on-the-fly statistical calculations
 - Short learning curve enables users to quickly explore their data



Sharing results

- Visualization tools make it much easier to dive into large data sets
- Designed to be interactive - select points, date ranges, areas, etc.
- Available to all employees (with permission) through web browser



Filtering

- Filters allow the users to quickly customize the information
- One dashboard with current information can replace many static reports
- Once filtered, users can
 - Save custom views
 - Share custom views with others
 - Set a view as the default
- Filters may also be included as part of a web link to the visualization

Initial Period End Date
January, 2012

Final Period End Date
January, 2015

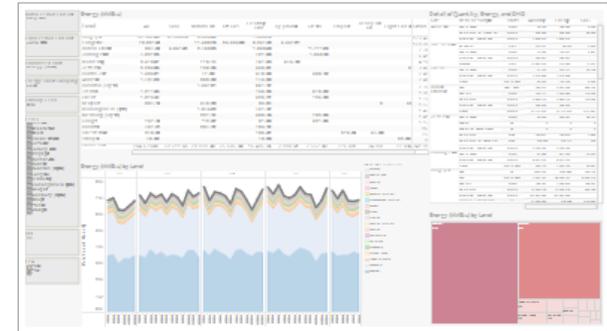
Purchased Units
Energy (MMBtu)

Energy Chart Grouping
Level

Primary Level
Site

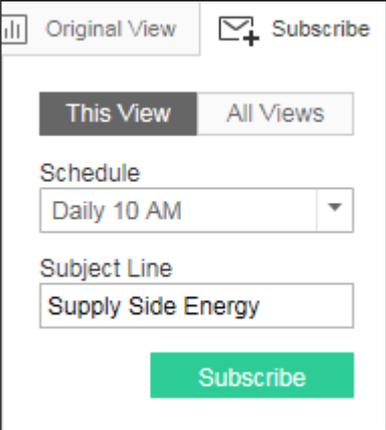
Level

- (All)
- Anniston
- Chestertown
- Ghent
- Indian Orchard
- Jefferson
- Jurong Island
- Kingsport
- Kohtla-Jarve
- Kuantan
- Kuantan (Crystex)
- Longview
- Middelburg
- Monongahela
- Newport
- Nienburg
- Sauget
- Trenton
- Uruapan



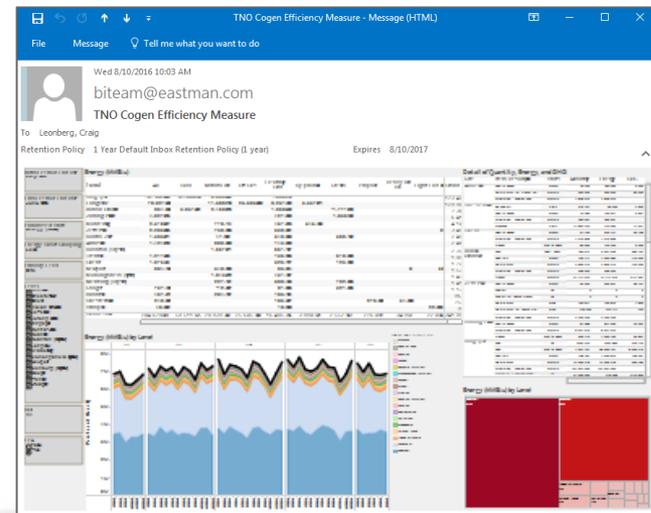
View subscriptions

- Users may set up regular reports to any views of interest
- User selects frequency (e.g. every day, weekdays, monthly, etc.)
- Email will contain snapshot of the current visualization
- Clicking on the snapshot will open the interactive web dashboard



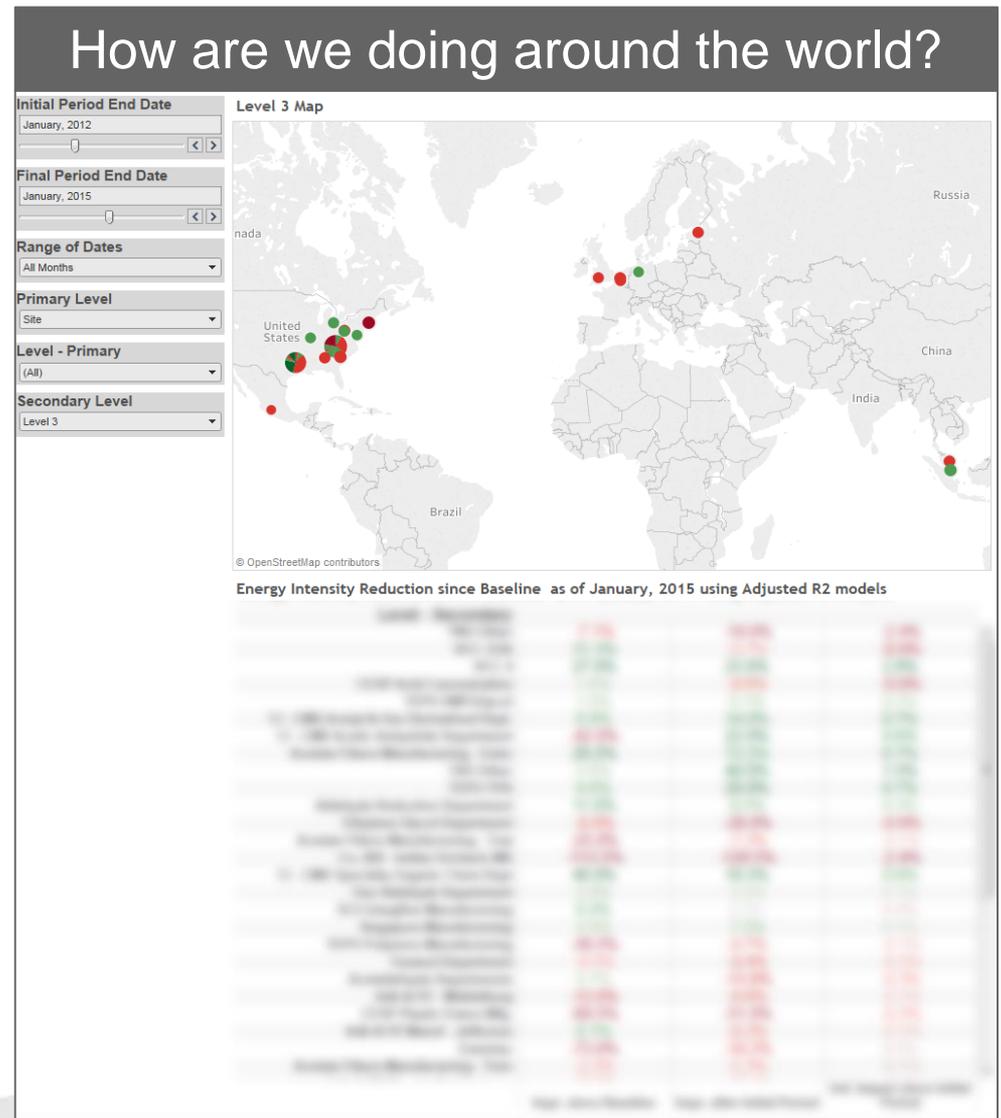
The screenshot shows a subscription form with the following elements:

- Buttons for "Original View" and "Subscribe" (with an envelope icon).
- Buttons for "This View" (selected) and "All Views".
- A "Schedule" dropdown menu set to "Daily 10 AM".
- A "Subject Line" text box containing "Supply Side Energy".
- A green "Subscribe" button at the bottom.

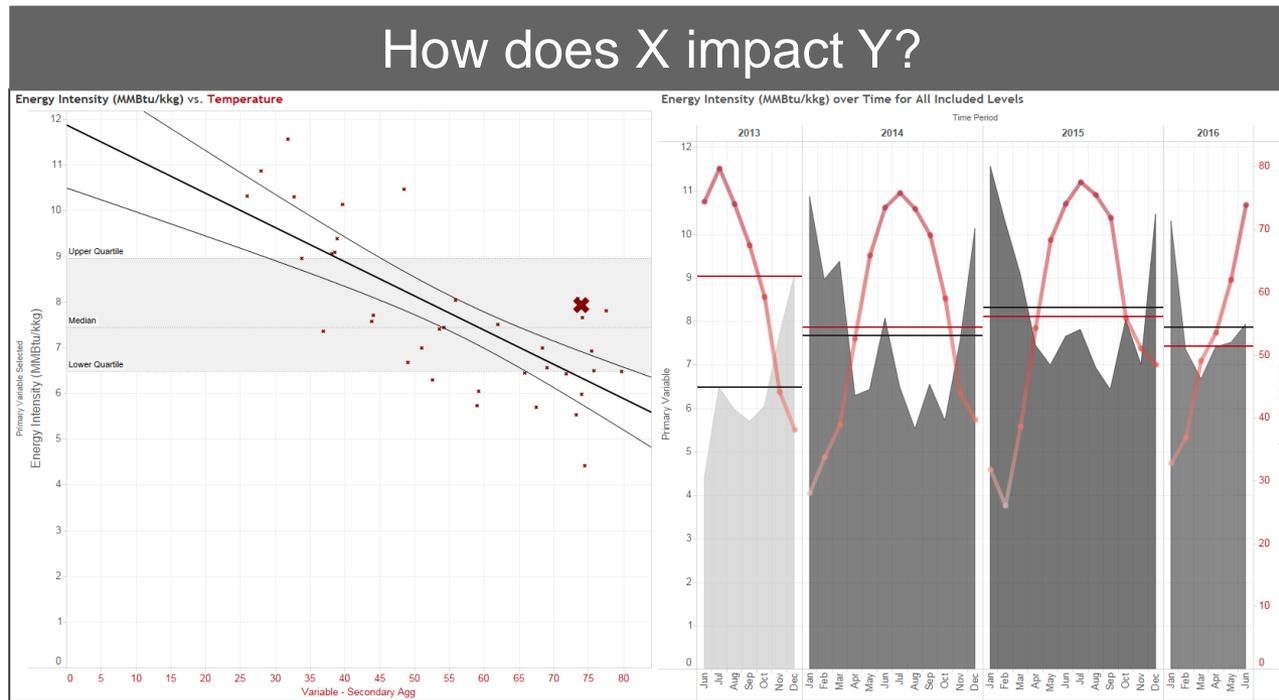


Mapping

- Summarize by location
- Size and color can help convey information
- Level of detail controlled by filters and parameters
- Interactive capability
 - Hover over map items to see information and energy data
 - Select any location on the map to filter results shown in other graphs and tables on the dashboard



Investigation

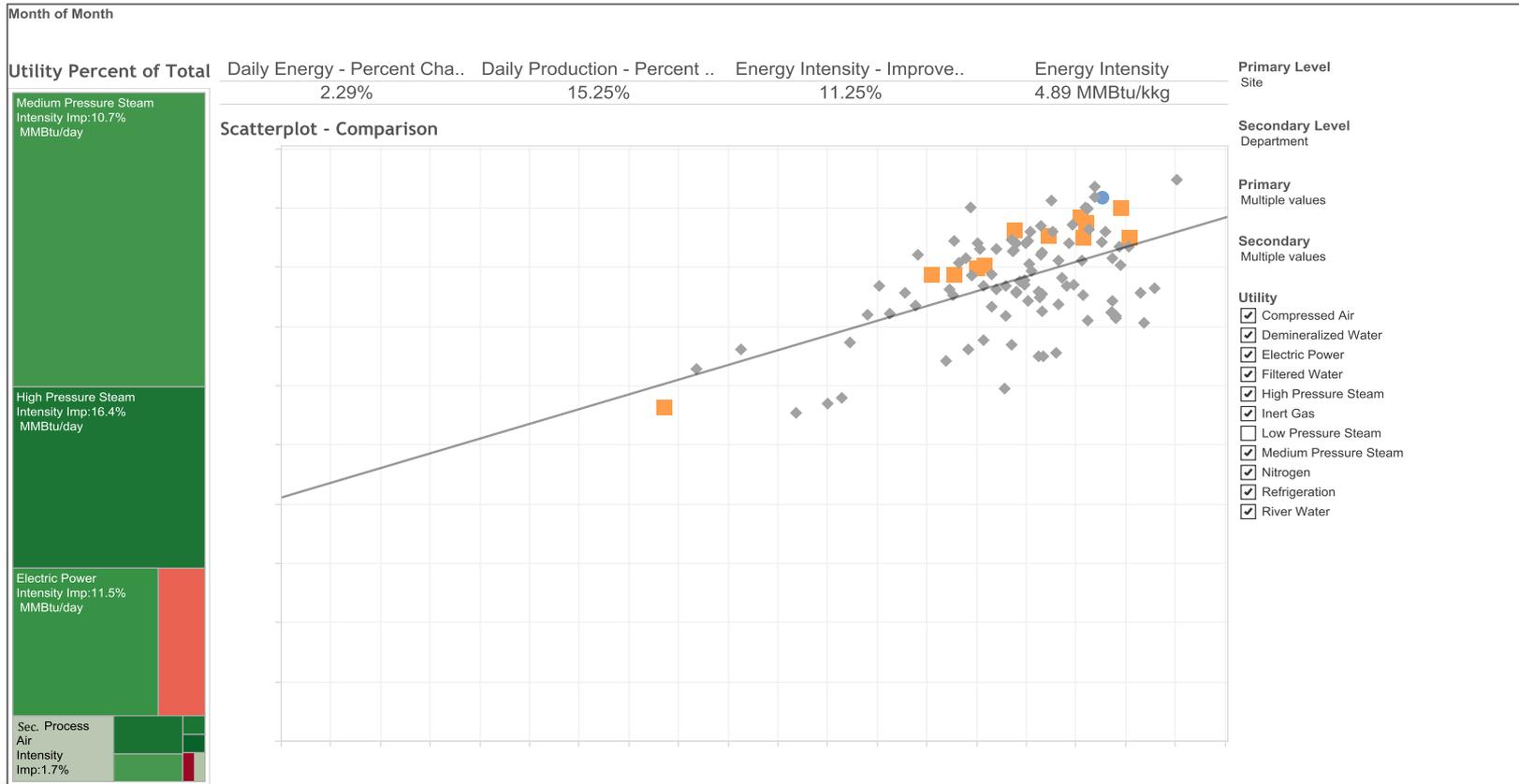


- Select any variables and date range to quickly evaluate relationships
- Example shows energy intensity versus temperature for one area
- Can lead to opportunity (e.g. can insulation be improved?)

Enable more detail

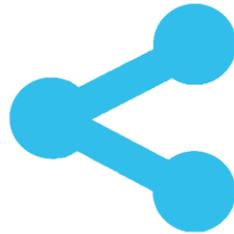
Apply the same approach at a more detailed level

- Separate energy use by utility
- Include sub-meter data to enable drill-down capability



Sharing results

- Tables and views in SQL server act as a central store of all energy information
- Can be connected directly to other programs

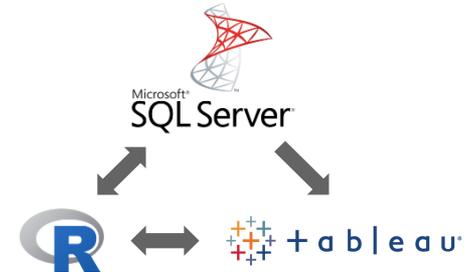
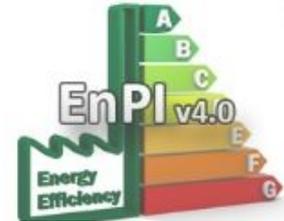


R
Excel
Access
JMP
Minitab
Matlab
Etc.

- Examples of other applications
 - Utility impact in product life cycle assessments
 - Utility optimization models

Summary

- Data analytics are a vital part of an energy management program
- Strive to make the process from data collection to reporting as streamlined as possible
- EnPI is a flexible option that's ready to go
- Eastman uses a combination of SQL Server, R, and Tableau to analyze corporate-level energy data and drive improvement
 - Scalable storage to maintain all corporate energy data in one place
 - Interactive dashboards enable users to do their own ad-hoc analysis
 - Many users may have simultaneous access to the data



Questions

