A Portable Educational Model for an Energy Management System of Duke Energy

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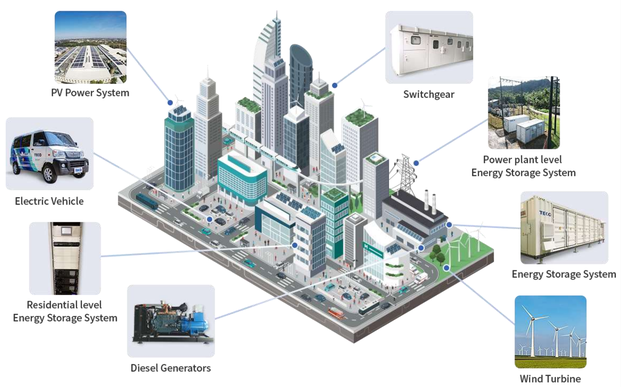
ABSTRACT

Duke Energy is facing several challenges due to the retirement of coal power plants which must be replaced with equally reliable resources. Thus, to meet rising energy utility demand, especially considering ambitious clean energy projects, the company must gain public support, prioritize electricity system education, and attract talented young people. Therefore, this study seeks to outline the procedures for developing an instructional framework for an energy management system designed for Duke Energy's power production plants. The goal is to give a concise and straightforward analysis of how various power generation facilities respond to the daily energy needs of urban regions and during fluctuating weather conditions. To ensure the optimal functioning of the model, a careful selection of both the hardware and software components which guarantees to fulfill the specifications outlined by the sponsor, including lightweight design, plug-and-play capability, synchronization, and resolution while minimizing costs. The model is used to play and synchronize eighteen videos made from real-time data and MATLAB code, which are played for five minutes using the HTML script. The model includes case studies which engineers may use to assure reliable grid integration of conventional and renewable energy sources while providing an accessible presentation to the public.

INTRO / GOALS / OBJECTIVES

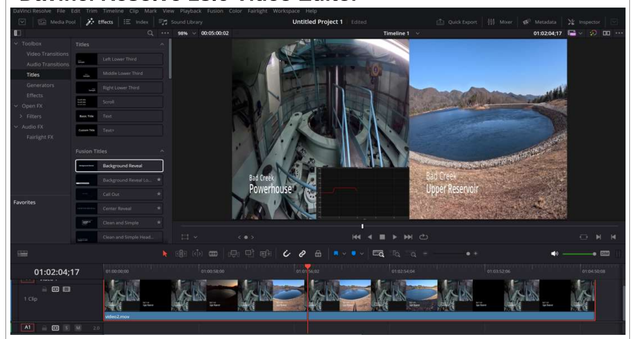
- Create a mobile representation of the electric utility grid
- Illustrate the necessity of dispatchable generation
  - Highlight the value of pumped storage hydro
- All ages can comprehend the material presented



METHODS

- **GoPro Camera:** the system was initialized by generating an onboard time-lapse by compiling a series of pictures captured over a specific duration.
- **Davinci Resolve 18.1:** Once the camera was selected and the footage was captured, it became essential to edit the recorded content.
- **MATLAB:** MATLAB was used to handle the data manipulation and visualization. The data is intended to mimic a typical day on the Duke Energy system.
- **Open Broadcaster Software (OBS):** After completing the video editing and generating load curves using MATLAB, OBS was used to capture screen recordings of the graphs while they were plotted.

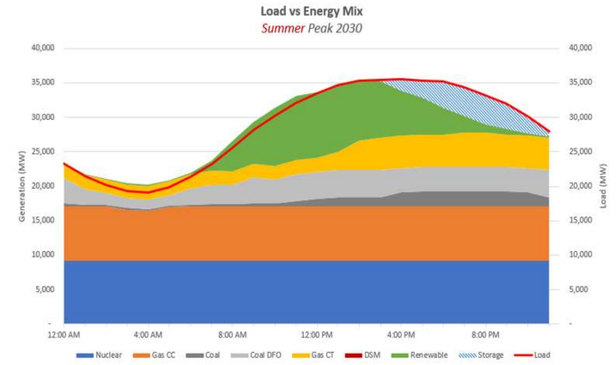
Davinci Resolve 18.6 Video Editor

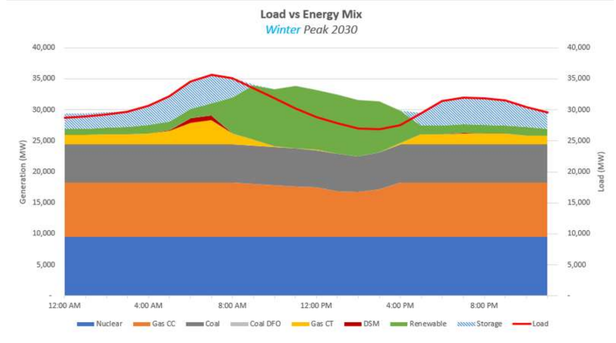


RESULTS

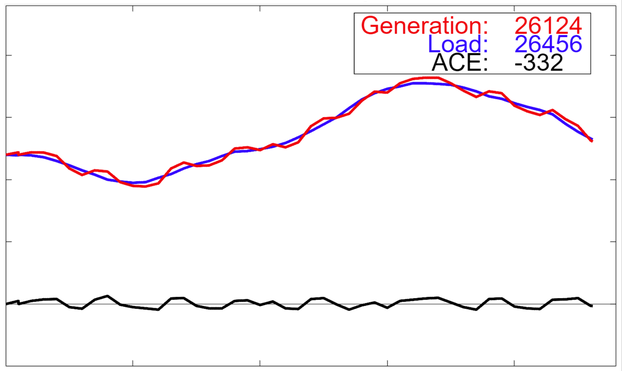
In phase 1, the team produced three five-minute time-lapse videos comprised of eighteen total videos. Each video was named and stored locally on the laptop alongside the HTML script that opened in Microsoft Edge. The HTML script calls three videos, then preloads them into a webpage. Intel graphics command center was used to manipulate the on-board graphics of the laptop. The integrated graphics of the laptop then viewed the three individual displays as one large display. In phase 2, the team successfully created a summer model to complement the winter model and made substantial visual improvements to the winter model.

Video Displays

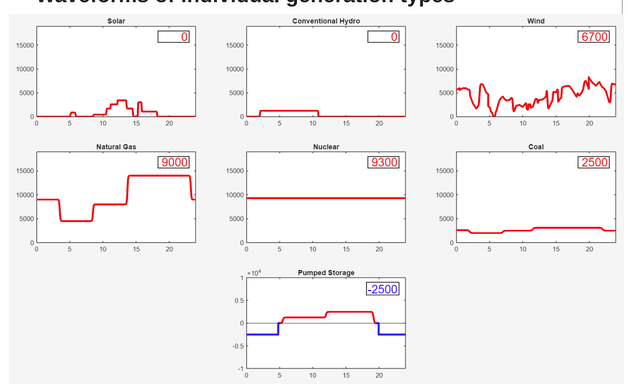




Demand and Net Generation Graph



Waveforms of individual generation types



CONCLUSIONS AND RECOMMENDATIONS

By the project deadline, the team completed the project and took away many lessons learned. Duke Energy was satisfied with the quality of the product and provided funding for further work on the model. For the third iteration of the project, these are the goals:

- Incorporate more timelapse footage
- Use a softer background color on the plots
- Improve synchronization
- Get summer and winter footage separately, instead of manipulating footage
- Add directional arrows to help viewer discern powerhouse rotations
- Re-capture tailrace footage from a different angle to allow viewer to better understand the model
- Increase video duration to allow timelapse footage to be more discernable

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