Experiments and actions on the pilot projects 2 until 30.06.2024

1. Data Anomalies, Safeguards, and Predictive Algorithms

The project has progressed significantly with regards to data collection and integration into the digital twin. During the simulation phase, several anomalies in the data were identified, such as missing model numbers, serial numbers, and energy readings. These issues were traced back to either faulty sensors or updates to the server. As a result, ISKRA d.o.o. committed to reviewing the logs to identify the root causes of the anomalies. Meanwhile, DIGITEH implemented fail-safes in the digital twin to identify and warn against the use of incorrect or incomplete data.

Additionally, predictive algorithms were discussed for energy consumption forecasting. For production lines, the energy consumption would be based on the production plans provided, which are made at least a week in advance. For energy producers like photovoltaics, self-learning algorithms were proposed, which would utilize weather forecasts to predict energy production based on historically similar days. For charging stations, a learning algorithm would use historical data to predict energy consumption with 95% credibility.

	string 1	string 2	string 3	string 4	string 5	string 6	string 7	string 8
string	Timestamp	Host IP address	Slave address	Is status active	Is correct located	Model number	Serial number	Description
424320	03.10.2024 14:01:21.574			true	true	iMC770 Quality		Selektivna linija A
424321	03.10.2024 14:01:21.606			true	true	iMC770 Quality		Selektivna linija B
424322	03.10.2024 14:01:21.642			false	false	iMC770 Quality		Valovno
424323	03.10.2024 14:15:00.054			true	true	IE38MD		Polnilnica 1
424324	03.10.2024 14:15:00.268			true	true	IE38MD		Polnilnica 2
424325	03.10.2024 14:15:00.446			true	true	IE38MD		Polnilnica 3
424326	03.10.2024 14:15:00.618			true	true	IE38MD		Polnilnica sotor
424327	03.10.2024 14:16:10.835			false	false	MC760 Analyzer		ST - Orodjarna
424328	03.10.2024 14:16:10.887			false	false	MC750 Recorder		ST - Obdelava Kovin - RL8
424329	03.10.2024 14:16:10.929			false	false	MC750 Recorder		ST - Pakirnica Nova - RL9

Figure 1: Partial data gathered from ISKRA d.o.o.

2. Understanding the Energy System and Data Flow

ISKRA's energy system was thoroughly discussed to understand the flow of energy within the factory and the corresponding data requirements. A data sample from one of ISKRA's energy producers was analysed, with each column in the data spreadsheet discussed to determine which data points were needed for the digital twin.

The team also reviewed the energy system block diagram, which illustrated the direction of energy flow and how each production line, power plant, and energy consumer/producer is connected. Transformers, acting as a bridge between the internal energy network and the external network, were highlighted as crucial components for managing energy import and export. Furthermore, discussions were held regarding the speed at which data can be gathered, with the fastest reliable interval being 15 seconds. The possibility of prioritizing energy distribution to consumers was also raised, though it was agreed that such a system would be implemented later.

ISKRA d.o.o. agreed to provide additional data on the working status of production lines and the workplan for the factory.

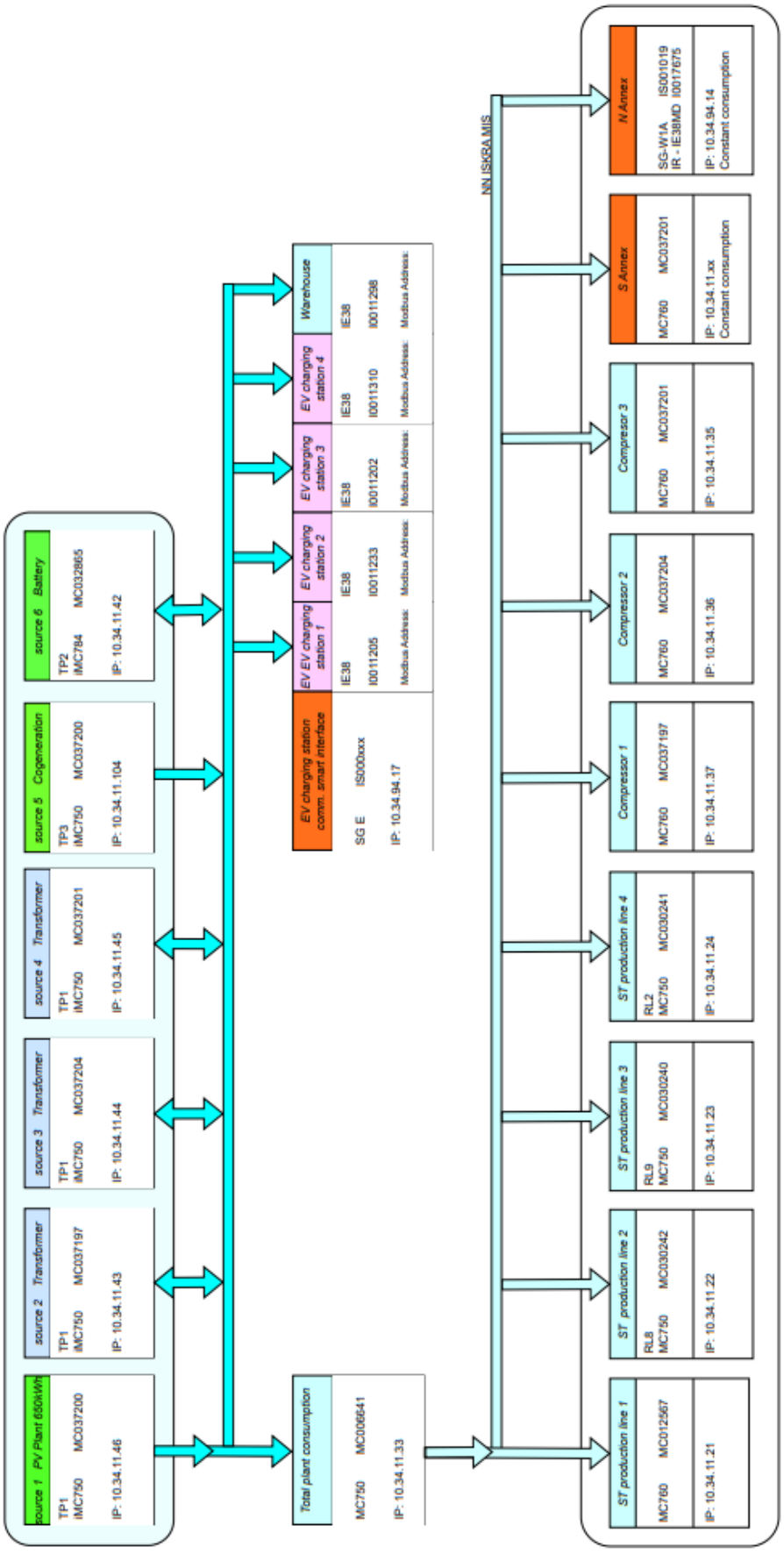

Figure 2: Energy path and connections between energy producers and consumers.

3. Adding and Removing Production Lines from the Digital Twin

As the project evolved, new challenges emerged regarding the inclusion and removal of production lines from the digital twin. ISKRA d.o.o. had added new production lines to the sensors, which required the digital twin to be reconfigured to detect and include these new lines. However, as production lines were relocated or decommissioned, there was a need to update the digital twin to recognize when a line should no longer be tracked.

A decision was made to add true/false variables to the energy gathering worksheets to indicate whether a production line should be monitored or removed from the digital twin. ISKRA d.o.o. agreed to add the necessary data, while DIGITEH updated the digital twin to allow for automatic removal of unnecessary production lines.

4. Development of the Digital Twin Model

As the project progressed, the self-building algorithms were updated, and new algorithms for self-adaptability and automatic removal of production lines were introduced. This allowed the digital twin to adapt to real-time data, adding new production lines, removing obsolete ones, and stopping data collection for lines with faulty counters.

Testing scenarios were run to evaluate the robustness of the digital model, including boundary condition checks, ensuring the model could handle various real-life conditions.

Figure 3: Real system and Digital Twin.

Conclusions and Next Steps

The project has made substantial progress, with key steps completed in data collection, predictive algorithm development, and digital twin integration. Moving forward, ISKRA d.o.o. will continue to gather energy consumption and production data, with a focus on finalizing the data for all production lines and energy producers. The digital twin will continue to evolve, with further updates to ensure it remains adaptable to new production lines and changes in the energy system.

DIGITEH will continue to refine the digital twin's self-adaptability and self-building capabilities, ensuring that the model remains accurate and functional as new data is introduced. Additionally, ISKRA d.o.o. will send the necessary 3D models or pictures of energy consumers/producers to DIGITEH to improve the presentation of the digital twin for ISKRA's directors.