The Advanced Analytics Development and Dissemination in a Life Company

Alice Guerini, Head of Data Science

29 Marzo 2022

OVERVIEW

A2A is an Italian multi utility and the first **life company** in the world.
Our presence spans the entire energy value chain, from the **production** to the **sale** of **electricity**, **gas** and **services**, to the provision of **e-mobility** and energy efficiency solutions. Every day, across our networks, we distribute electricity and gas, **drinking water** and heat for **district heating** and also we manage the **waste collection**.

6.862 Revenues (mln€)

364 Group result of the year (mln€)

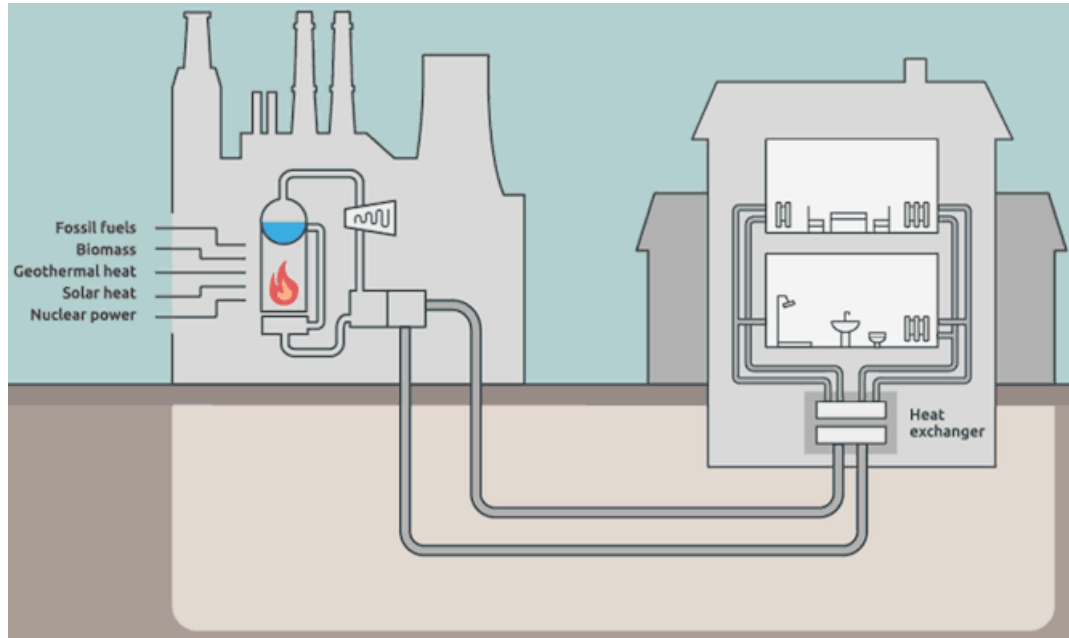**12.978** A2A Group People

a2a
LIFE COMPANY

THE A2A DISTRICT HEATING
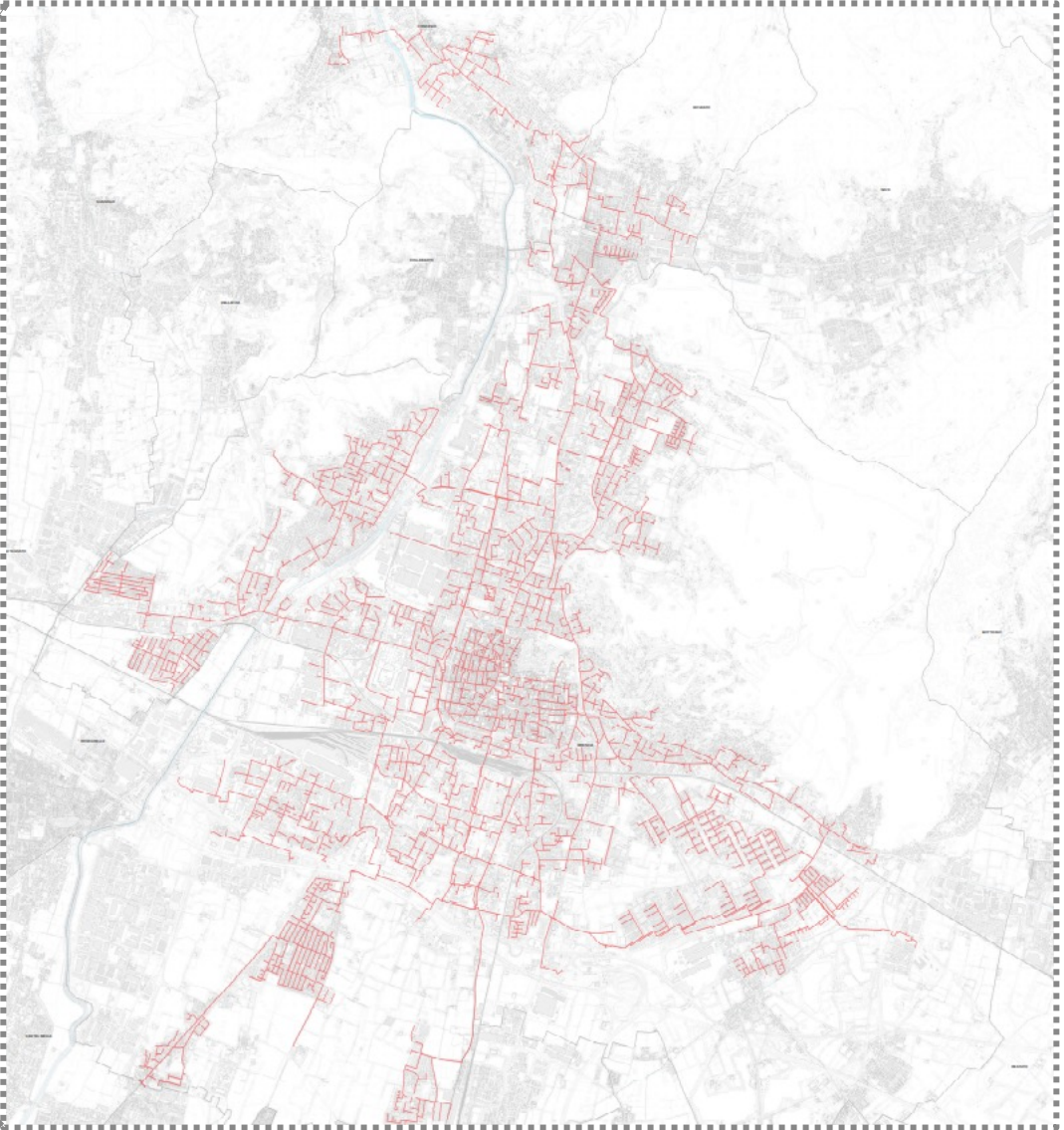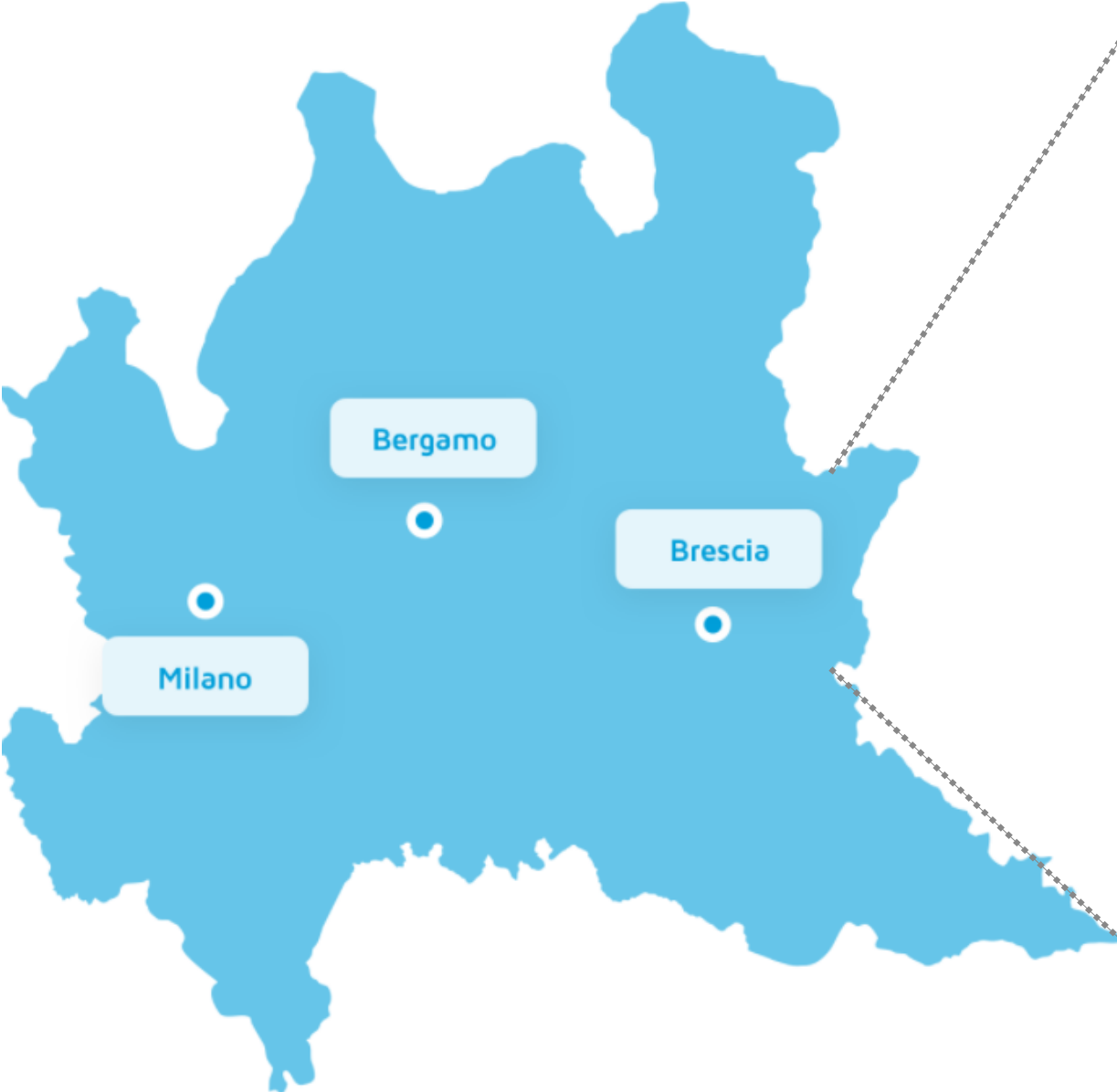
FOCUS ON BRESCIA DISTRICT HEATING

The district heating in Brescia now serves 70% of the city buldings, both residential and service sector.

177.770
Equivalent apartments connected

42,6 mln
Cubic meters heat up

678 km
grid

Saving emission (2020)

69.417 ton
Co2

circa
2,6 ton
PM10

107,1 ton
PNOX

BRESCIA

Centro Commerciale Frecciarossa

Crystal Palace

Palazzo Tosio

Palazzo di Giustizia

Teatro Grande

Tre Torri

Palaleonessa

Duomo Nuovo

Palazzo della Loggia

Università di Medicina e Ingegneria

Ospedali Civili

Museo Santa Giulia e Pinacoteca

Duomo Vecchio

a2a
LIFE COMPANY

a2a
LIFE COMPANY

HEAT DISPATCHING

District heating is a system for distributing heat generated in a centralized location through a system of **insulated pipes** for residential and commercial heating requirements such as space heating and water heating. The heat is often obtained from a **cogeneration plant** burning **fossil fuels** or **biomass**, but heat-only **boiler stations**, **geothermal heating, heat pumps** and **central solar** heating are also used. District heating plants can provide **higher efficiencies** and better **pollution control** than localized boilers.

Through a district heating network, the heat-producing plant pumps heated supply water to consumers where it is used as room-/floor-heating and to generate domestic hot water. The domestic hot water gets heated in a heat exchanger in which the heated supply water transfers its heat to the water coming out of the taps.
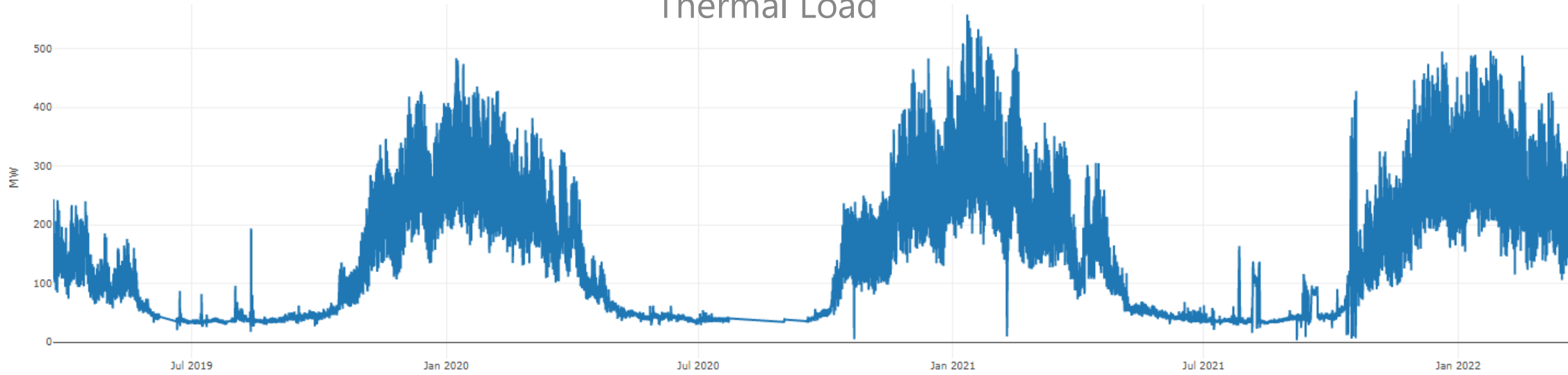
a2a
LIFE COMPANY

GOAL

Short-term forecasting of hourly thermal load from 1 day-ahead up to 7 days-ahead.

Every day, in the morning the forecast of the 7 days-ahead is provided.
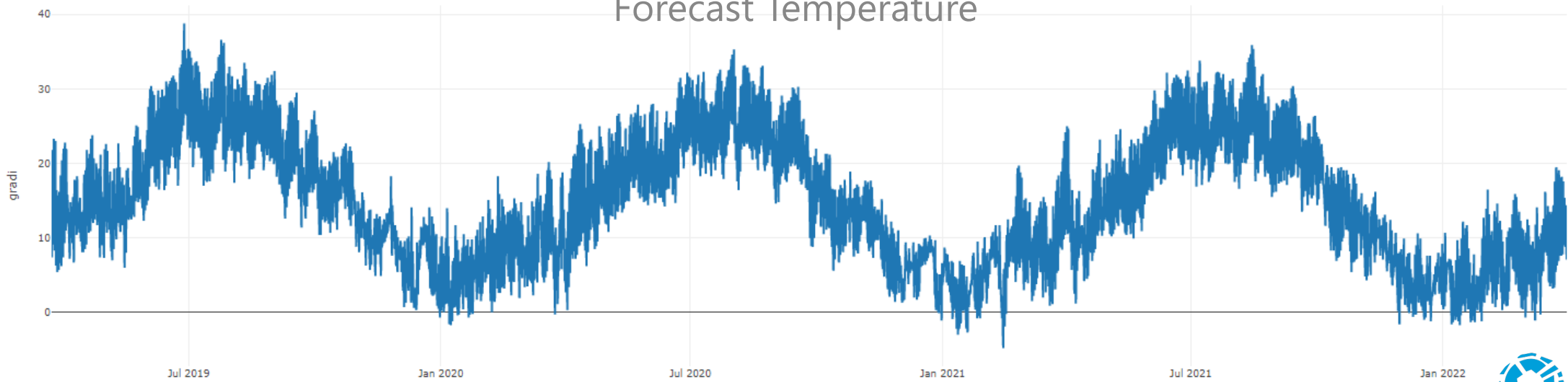
Optimize the heat produced by the power plant, in order to reduce the pollution emissions minimazing the production costs.
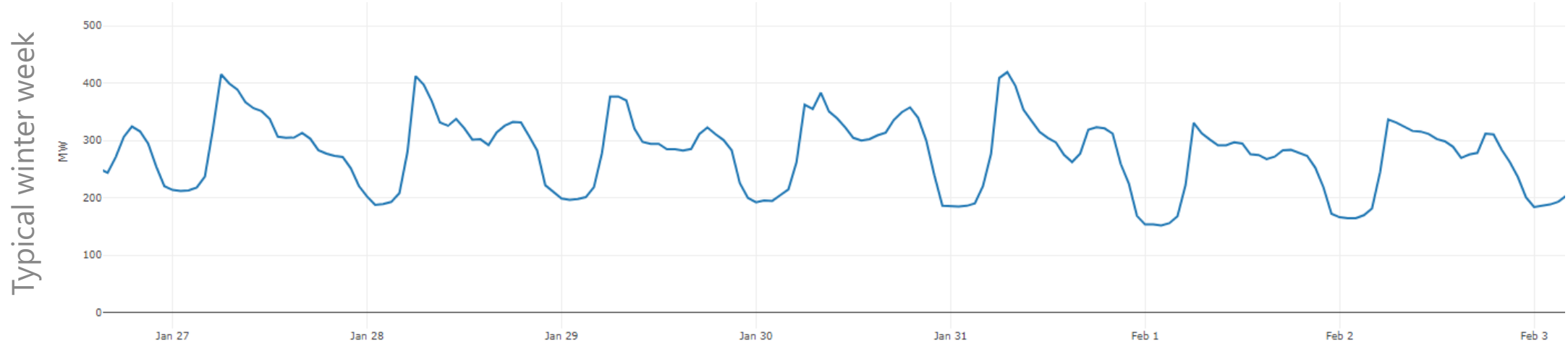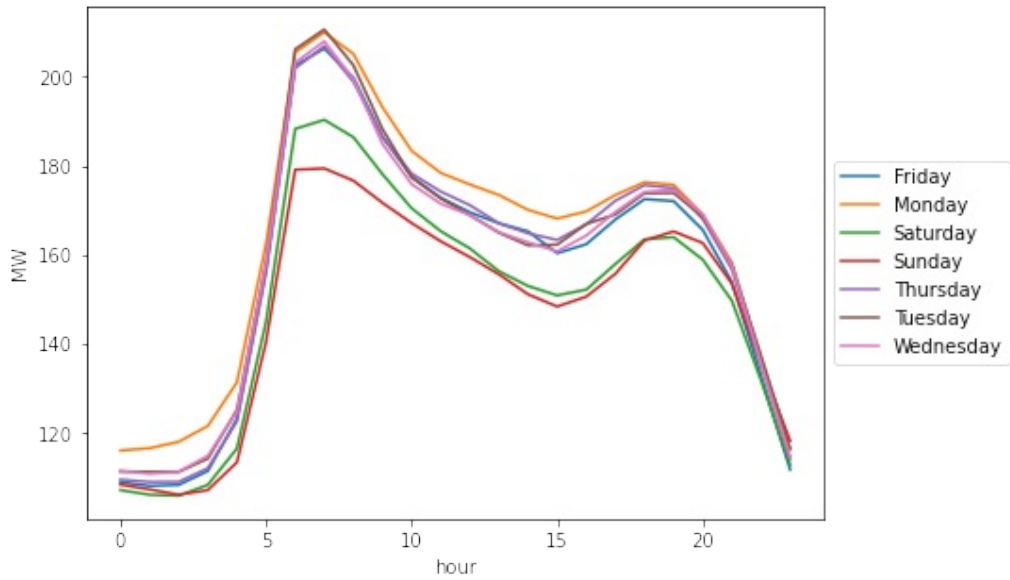
a2a
LIFE COMPANY

DATA EXPLORATION

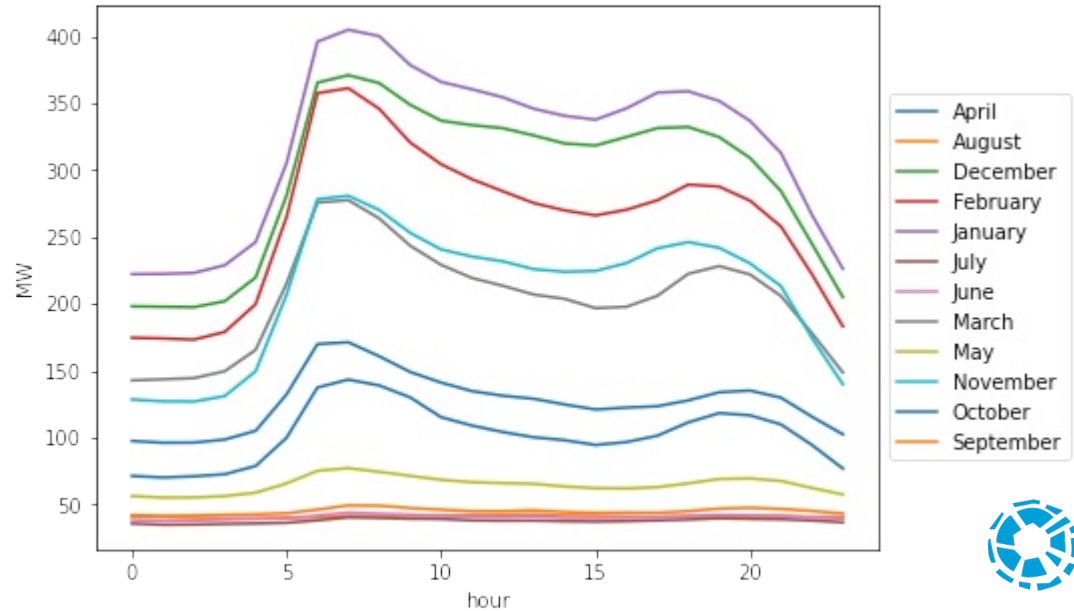Thermal Load

Forecast Temperature

DATA EXPLORATION
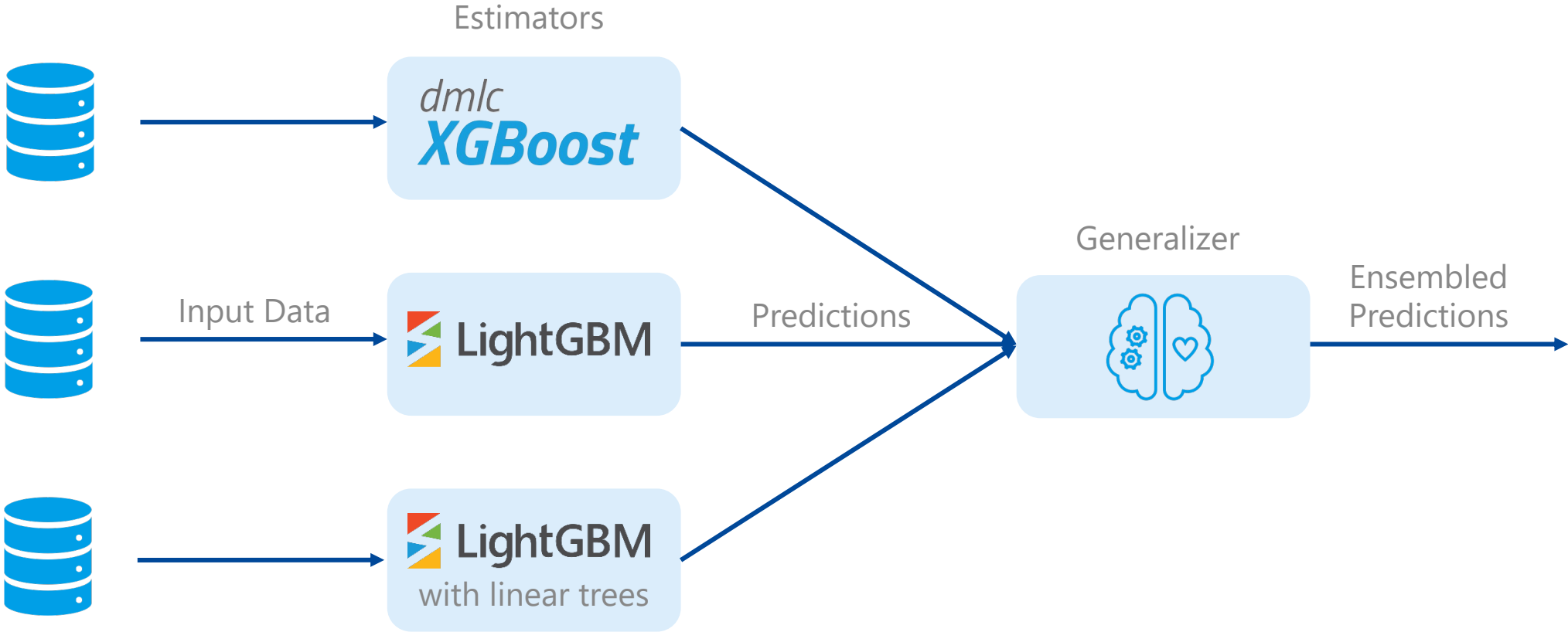
Typical winter week

Mean hourly power in each weekday

Mean hourly power in each month
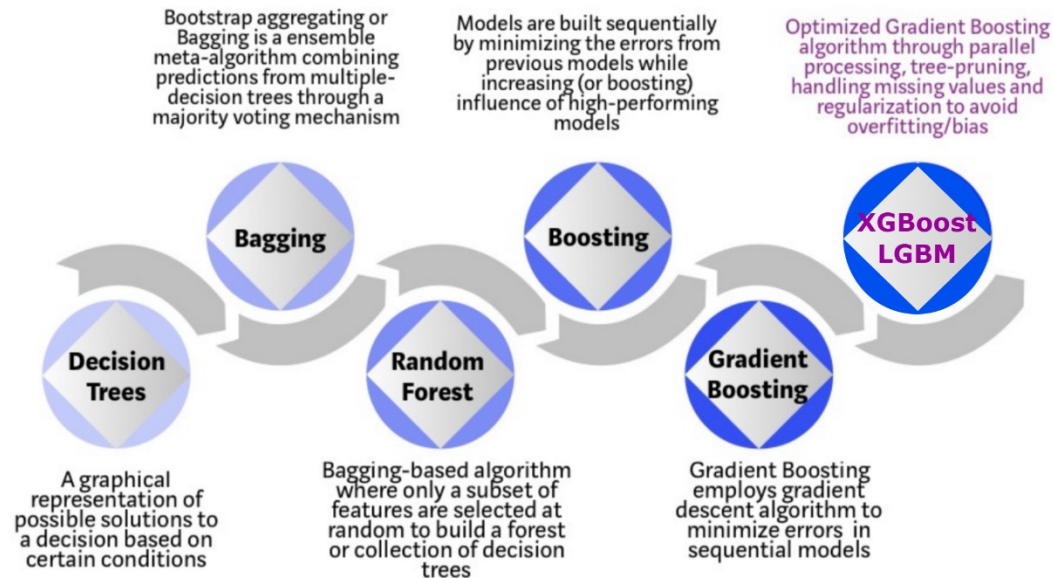
MODELING

MODELING

EXTREME/LIGHT GRADIENT BOOSTING:
is a decision-tree-based ensemble Machine Learning algorithm that uses a gradient boosting framework.
It is an optimized distributed gradient boosting library designed to be highly efficient, flexible and portable.

Bootstrap aggregating or Bagging is a ensemble meta-algorithm combining predictions from multiple-decision trees through a majority voting mechanism

Models are built sequentially by minimizing the errors from previous models while increasing (or boosting) influence of high-performing models

Optimized Gradient Boosting algorithm through parallel processing, tree-pruning, handling missing values and regularization to avoid overfitting/bias

Bagging

Boosting

XGBoost LGBM

Decision Trees

A graphical representation of possible solutions to a decision based on certain conditions

Random Forest

Bagging-based algorithm where only a subset of features are selected at random to build a forest or collection of decision trees

Gradient Boosting

Gradient Boosting employs gradient descent algorithm to minimize errors in sequential models

THE APPROACH
- Recursive forecasting approach
- Every day, all the models are retrained and the best parameters are selected

FEATURES
- Lagged power features (24 hours, 48 hours,... 7 X 24 hours),
- Lagged temperature features (from 1 to 24 lag)
- cyclical encoding (sin and cos of every seasonality period)

a2a
LIFE COMPANY

RESULTS

forecast
actual

1 day-ahead

forecast
actual

7 days-ahead
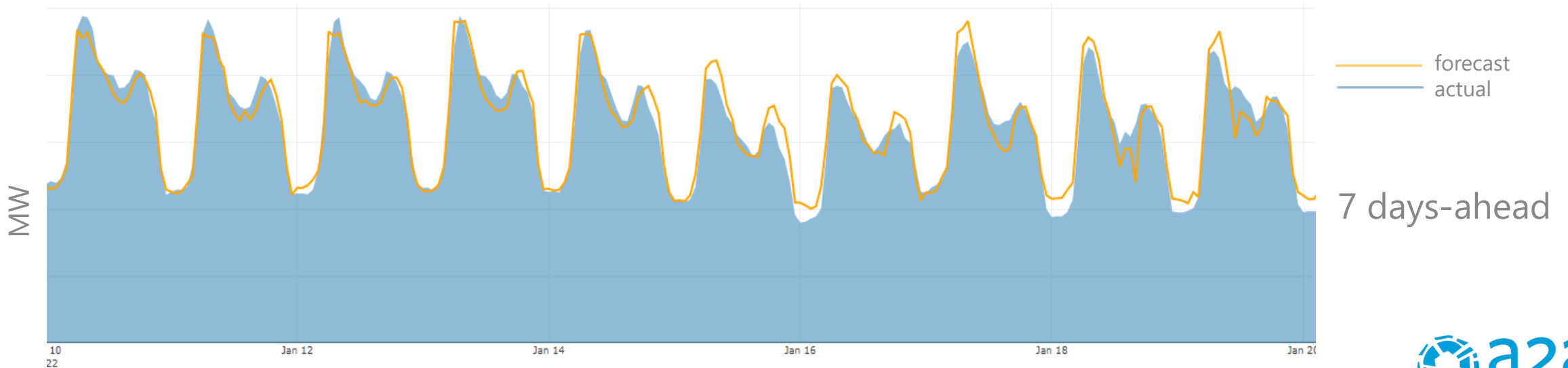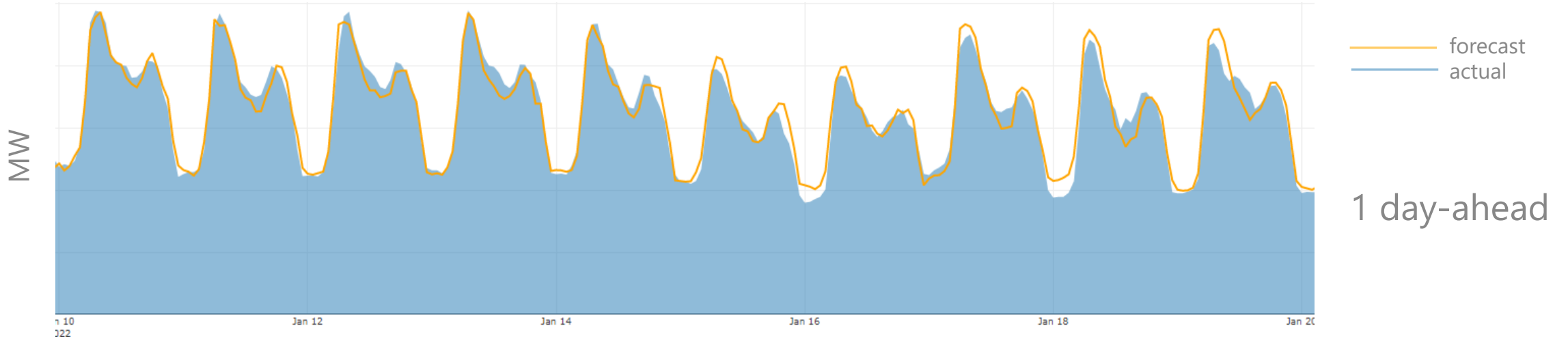
RESULTS - PERFORMANCE

The ensemble model is tested on the the last thermal season (2021-2022) on Brescia and East Milan plants, and it is compared to the benchmark model previuosly used.

1 day ahead (BS)	Ensemble	Benchmark model
MAPE*	5,64%	8,82%
MAE**	8,82 MW	20,02 MW
7 days ahead (BS)	**Ensemble**	**Benchmark model**
MAPE*	7,95%	13,5%
MAE**	17,94 MW	29,49 MW

1 day ahead (MI)	Ensemble	Benchmark model
MAPE*	7,71%	18,3%
MAE**	3,83 MW	8,2 MW

* $\frac{100\%}{n} \sum_{t=1}^{n} \left| \frac{A_t - F_t}{A_t} \right|$, where A is the actual load, F is the forecast

** $\frac{\sum_{i=1}^{n} |A_t - F_t|}{n}$

a2a
LIFE COMPANY

CONCLUSION

- ✓ Our short-term predictor outperforms both the 1-day ahead both the 7-days ahead forecaster used previously in the plant
- ✓ The 1-day ahead ensemble model reduce the MAPE of nearly 60% and the MAE of nearly 40%
- ✓ The 7-days ahead ensemble model reduce the MAPE of nearly 60% and the MAE of nearly 60%
- ✓ The ensemble models reduce the CO_2 emissions, in particular only considering the East Milan plats the estimated saving for 10.000 ton CO2/year.

NEXT STEP

- ✓ Develop a dispatching algorithm to optimize the usage of the plant power units, reducing the usage of the fossil fuels according to the **sustainability plan** of the A2A.

THANK YOU