



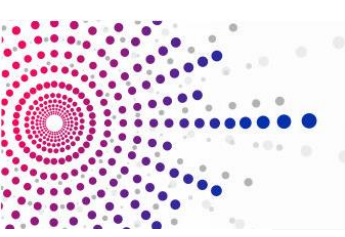
Artificial and Human Intelligence for Community-empowered Sustainable Energy Systems

AI-4-Energy: Data-driven analytic services for intelligent energy management

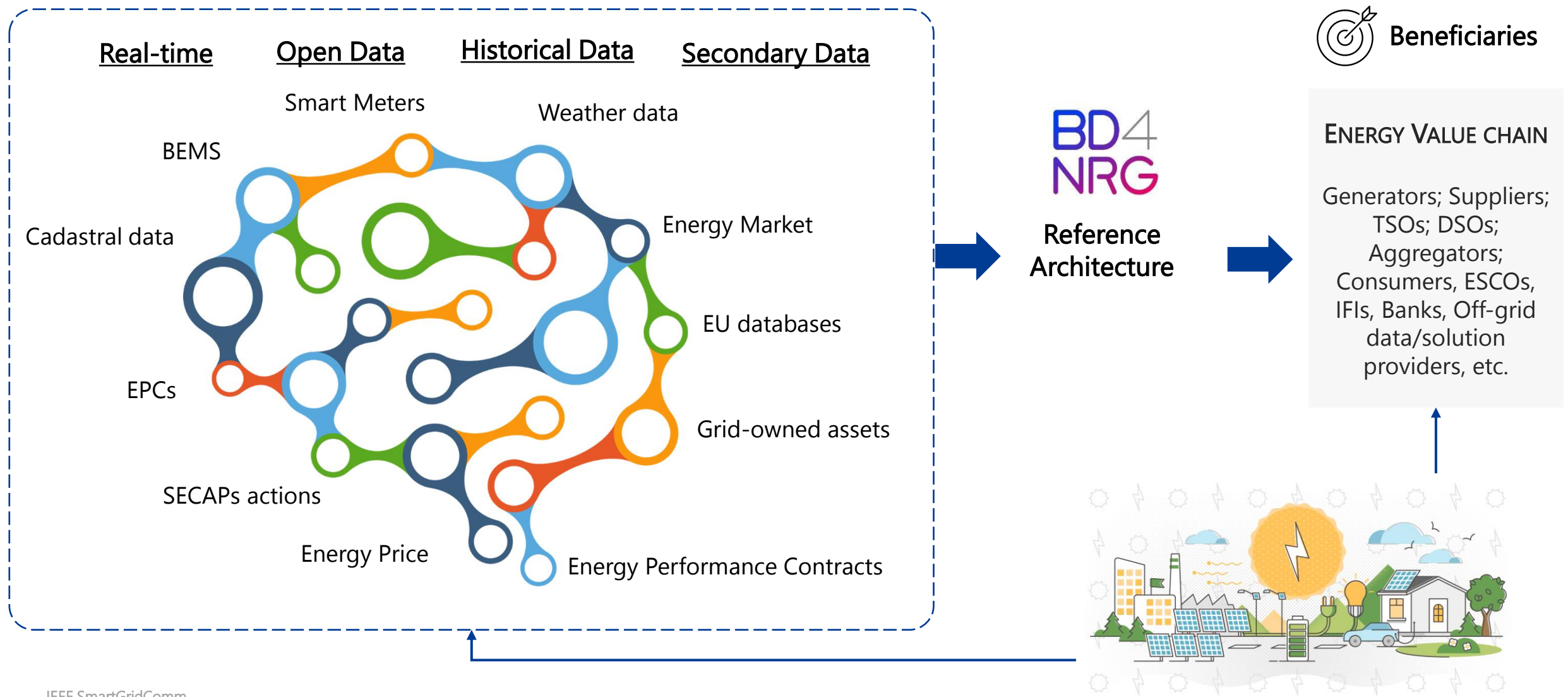
Dr Vangelis Marinakis

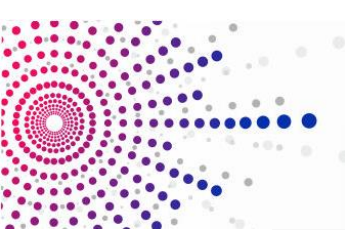
School of Electrical & Computer Engineer,
National Technical University of Athens





Data is Everywhere...





“AI-4-Energy Library” for energy analytics services

Different algorithms

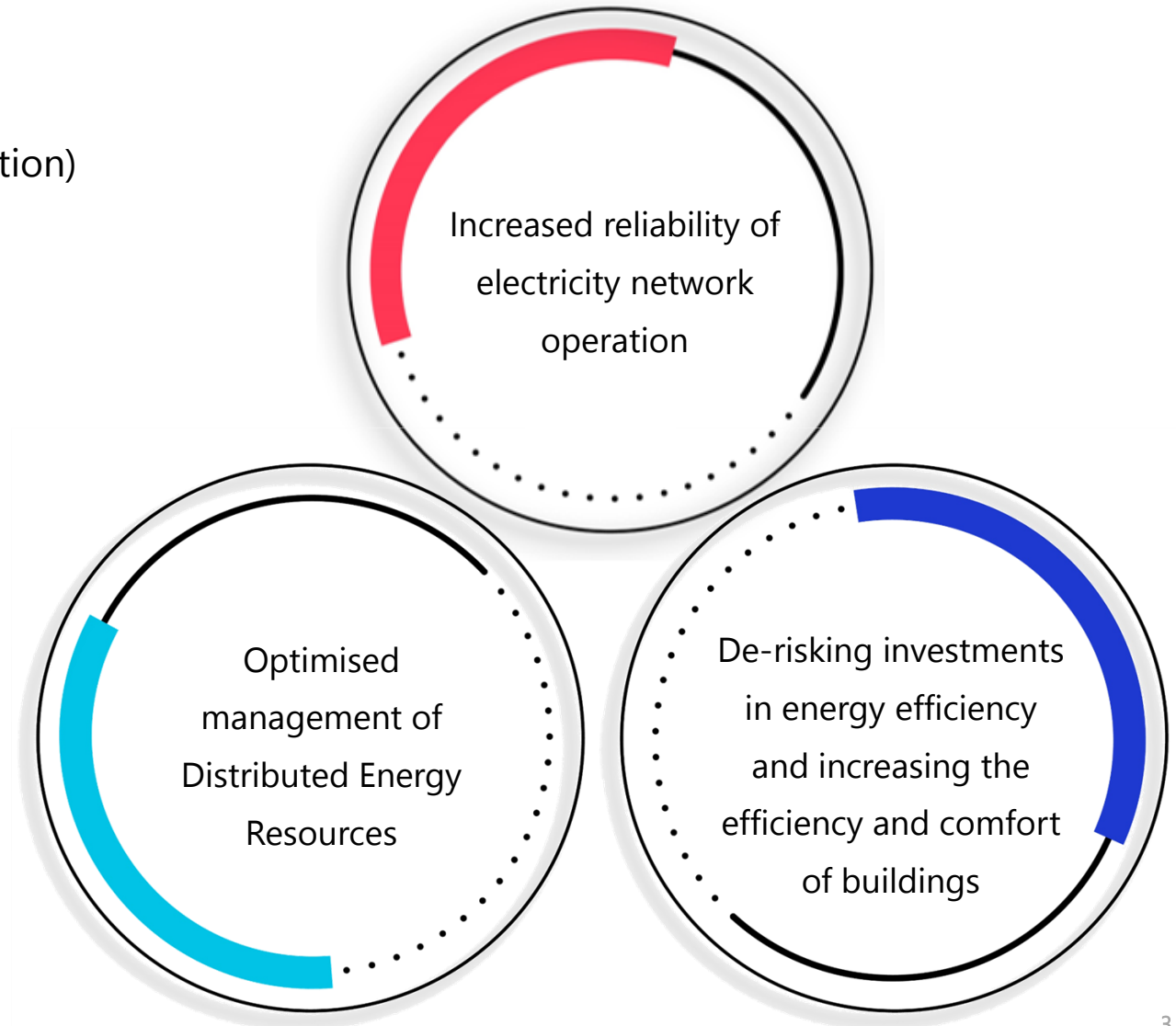
- ⇒ Supervised learning (Regression & Classification)
- ⇒ Unsupervised learning (Clustering & Recommendation)
- ⇒ Other (Optimization & Prioritization)

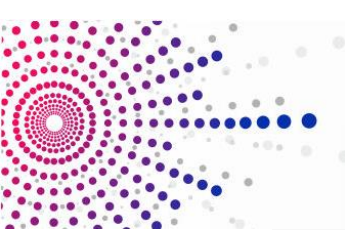
Different applications

- ⇒ Forecasting
- ⇒ Early-warning systems
- ⇒ Data analysis & understanding
- ⇒ Optimization
- ⇒ Decision support & Recommendations

Different models

- ⇒ Neural Networks (ANNs, RNNs, LSTMs)
- ⇒ Regression & Classification Trees
- ⇒ K-means
- ⇒ Support Vector Machines

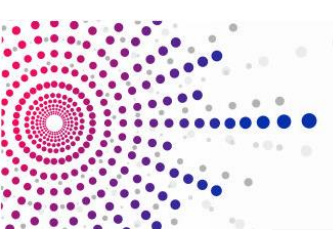




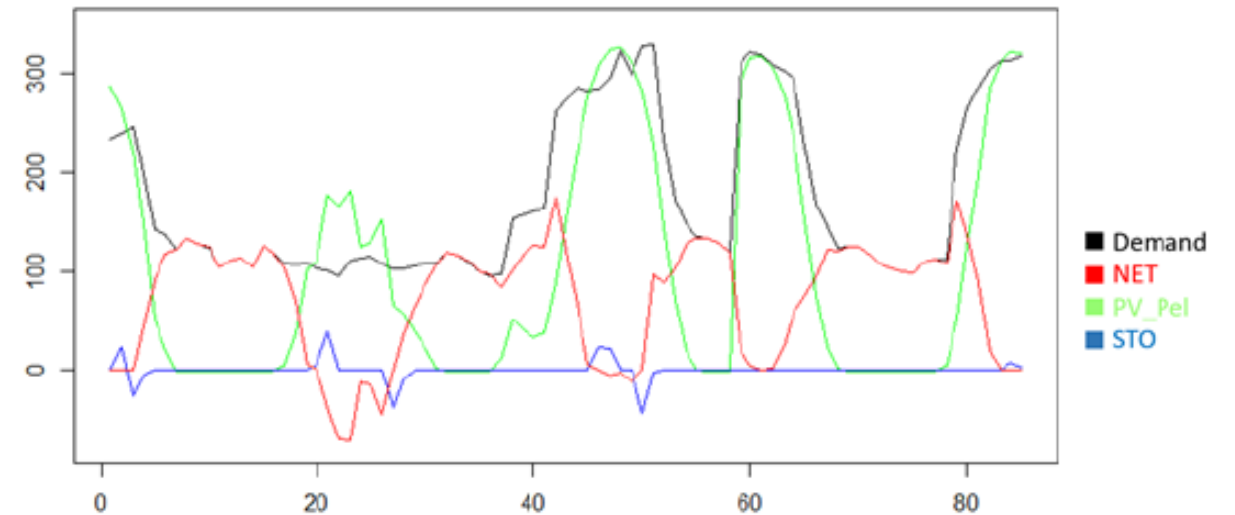
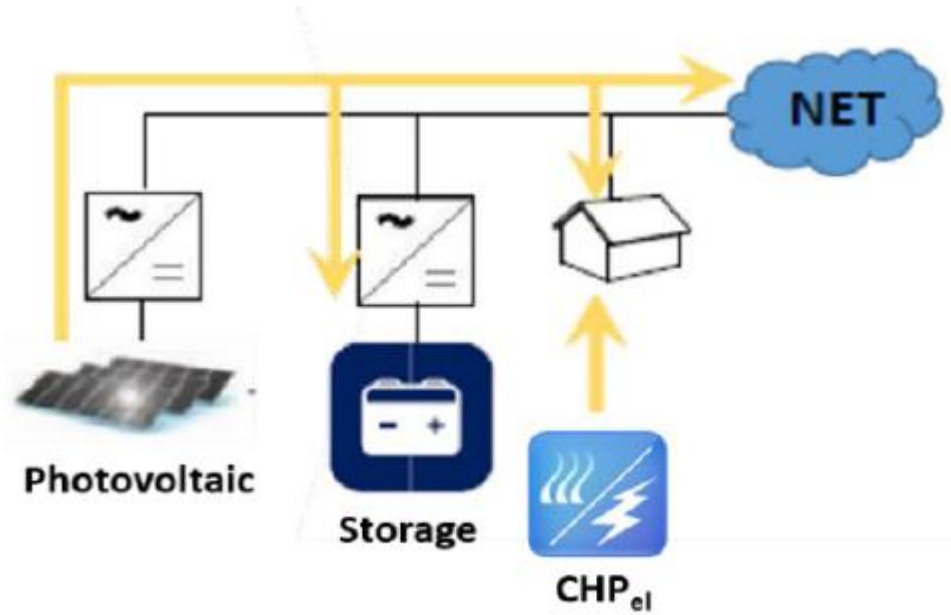
Increased reliability of electricity network operation

- ⇒ Integrating off-grid data with condition-based monitoring for enhanced predictive asset maintenance.
- ⇒ Cross-functional integration of grid operation with predictive asset management.
- ⇒ Cross-domain cross-functional integration of predictive asset management and grid operation while coordinating with EVs smart charging.
- ⇒ Cross-functional predictive asset management for MV grid planning.



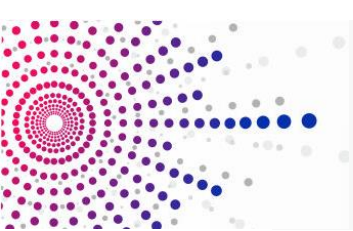


Scheduling the operation of heating and electricity systems towards energy cost optimisation

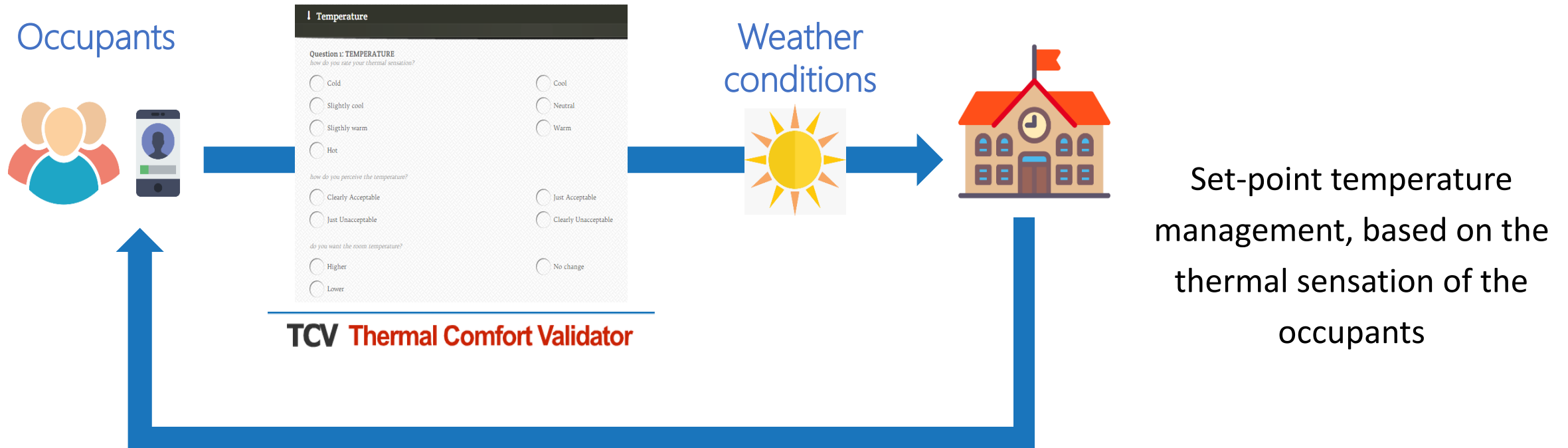


Electrical network of PV, storage, CHP and the grid

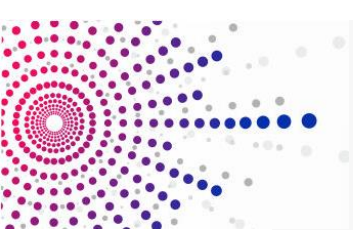
Marinakis et al. (2020). From big data to smart energy services: An application for intelligent energy management. *Future Generation Computer Systems*, 110, 572-586.



Weather-enhanced building thermal comfort prediction



Marinakis et al. (2017). Decision support for intelligent energy management in buildings using the thermal comfort model. *International Journal of Computational Intelligence Systems*, 10(1), 882-893.

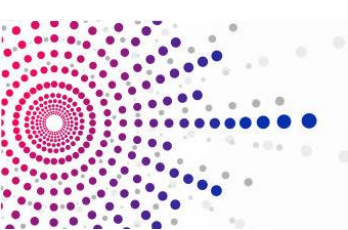


⇒ Support:

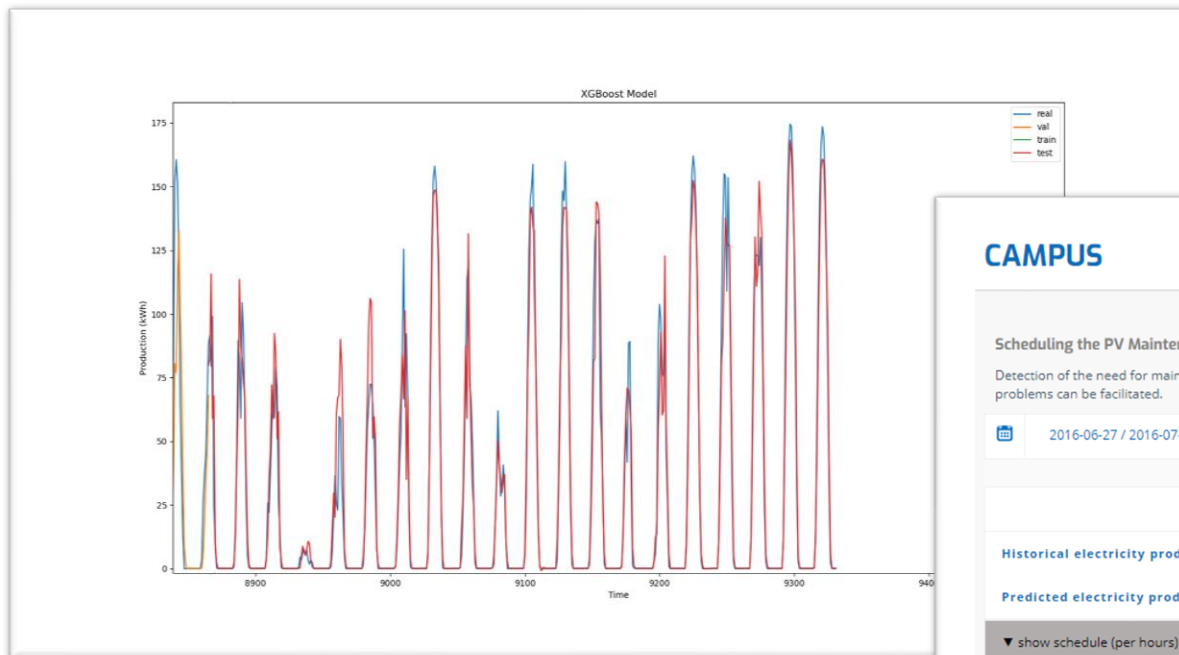
- (1) Harmonisation and data share of Energy Performance Certificates (EPCs).
- (2) Facilitate their compliance and checking procedures and finally
- (3) Contribute to de-risking investments in the EE sector, by analysing the refurbishment options contained in EPCs.

⇒ Assessment of the final energy consumption in the EPCs and the real consumption data from the smart meters.

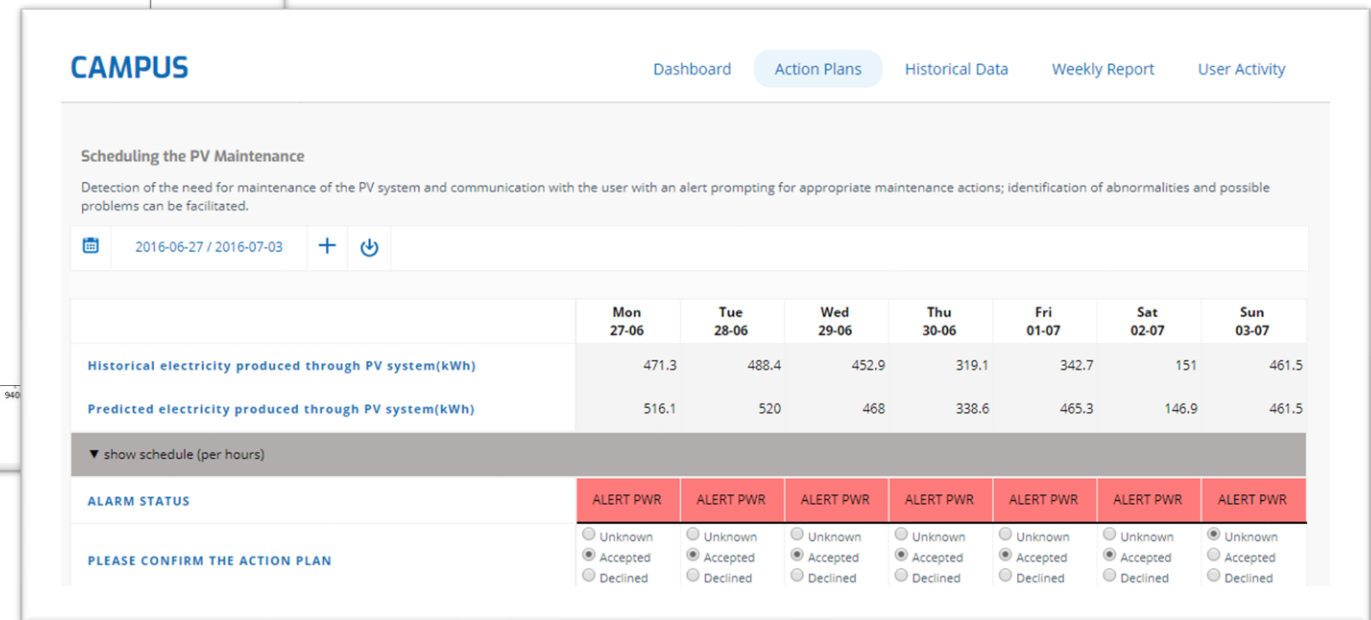
⇒ Improve EPC accuracy and reliability.



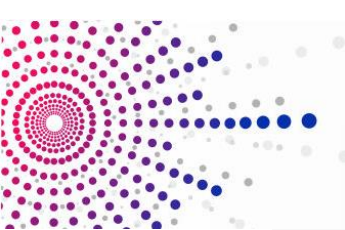
Scheduling the PV maintenance



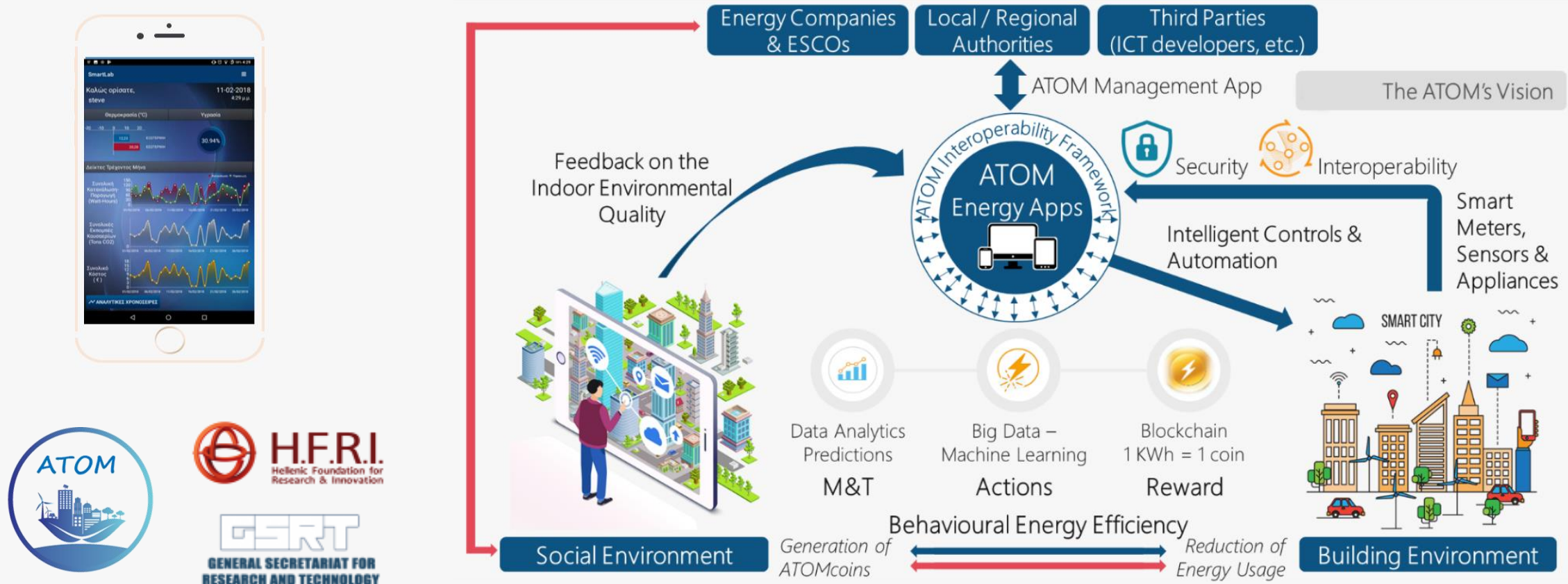
Models: LSTM, CNN, SVR, XGBoost,



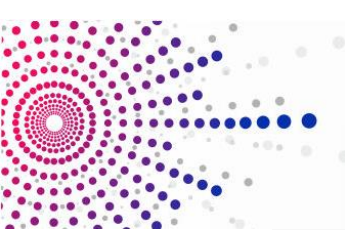
Dimitropoulos et al. (2021). Comparative analysis of AI-based models for short-term photovoltaic power forecasting in energy cooperatives. Intelligent Decision Technologies (in press).



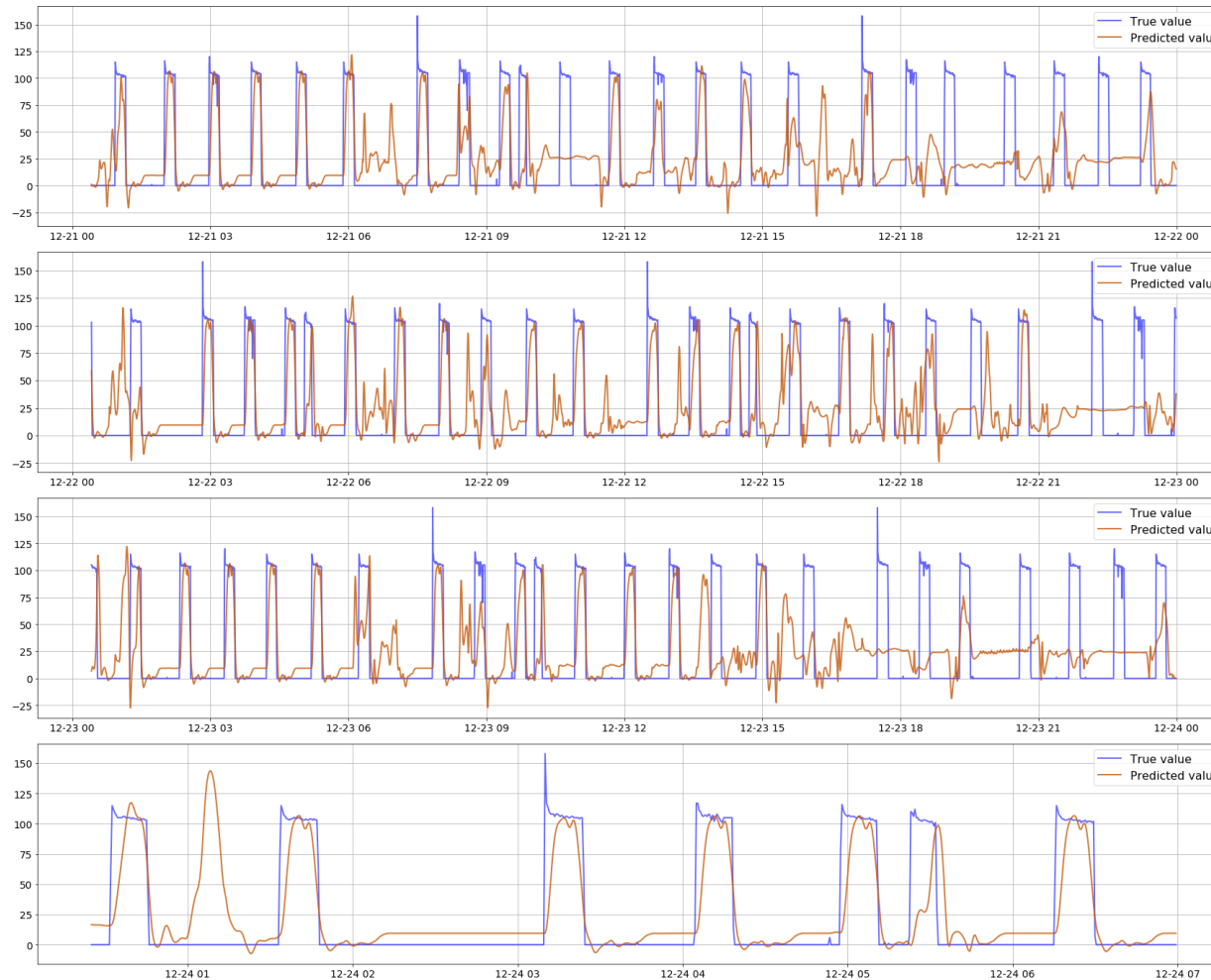
Behavioural energy efficiency



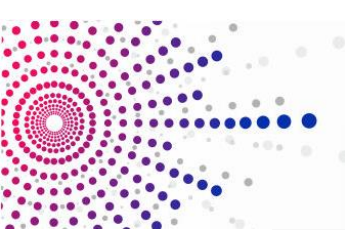
Doukas H., Marinakis V., Tselas J., Sgouridis S. (2018). Intelligent Energy Management within the Smart Cities: An EU-GCC Cooperation Opportunity. Chapter of the Book "Smart Cities in the Gulf". Editors: Wael A. Samad and Elie Azar. Springer Nature (ISBN: 978-981-13-2010-1).



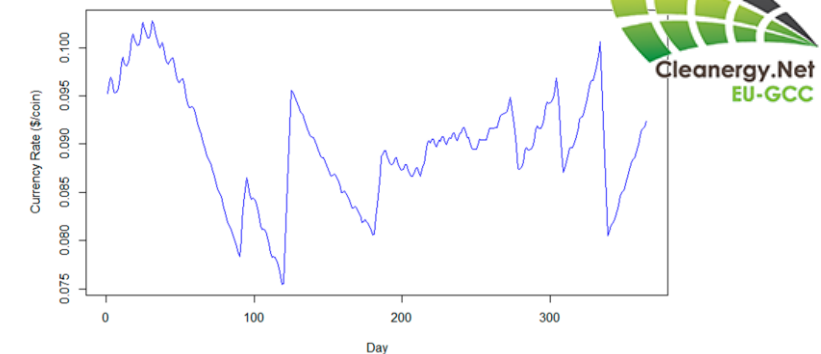
Energy disaggregation



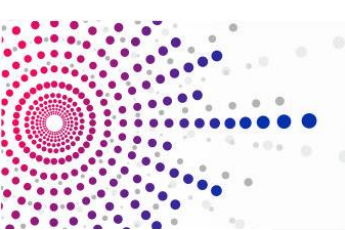
Separating an aggregate energy signal into the consumption of individual appliances in a household



- ⇒ **Digital energy currencies** can play an important role in the new open energy market.
- ⇒ Make people more aware of the dependence of energy consumption on their behavior.



Marinakakis et al. (2020). From intelligent energy management to value economy through a digital energy currency: Bahrain city case study. *Sensors*, 20(5), 1456



Predictive analytics for energy efficiency investments de-risking

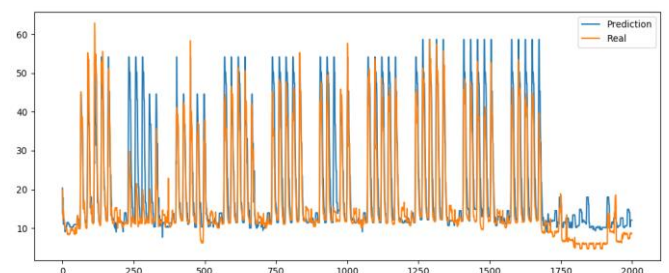
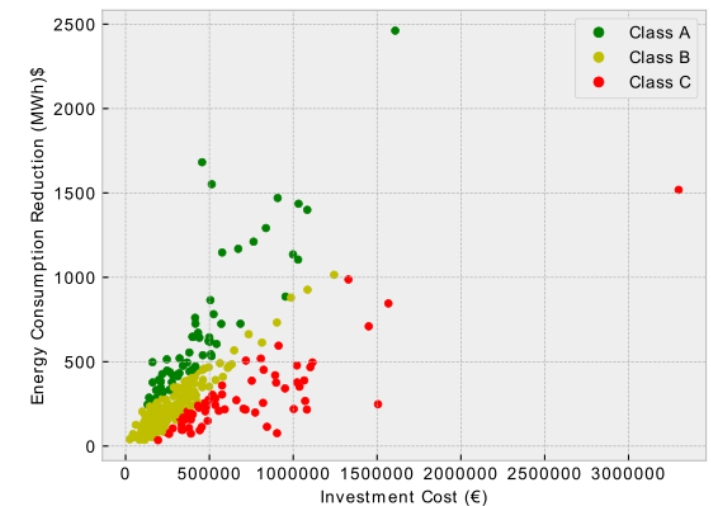
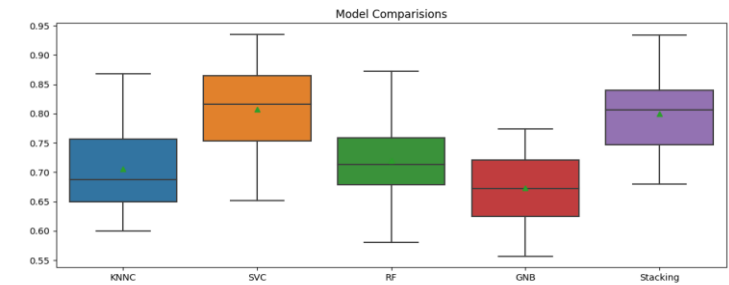
⇒ Comparative evaluation of ML models

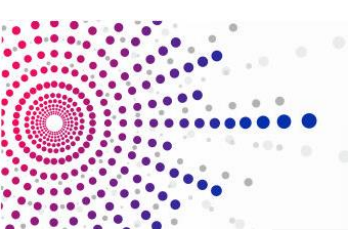
Several ML Classification Models have been trained and tested for energy efficiency investment benchmarking (KNN, SVC, Gradient Boosting, Random Forests etc.)

⇒ IPMVP-based Actual Savings Calculation

School Data from Gulbenes Lika Street 21 2nd High School have been used to train ANN models for consumption prediction.

⇒ Providing **investors/financiers** (e.g., commercial/green investment banks, institutional/insurance funds, etc.) and **project developers** (public/local authorities, energy providers, ESCOs, construction companies, etc.) with data and tools to identify sustainable investment pathways and decrease the investment risk.

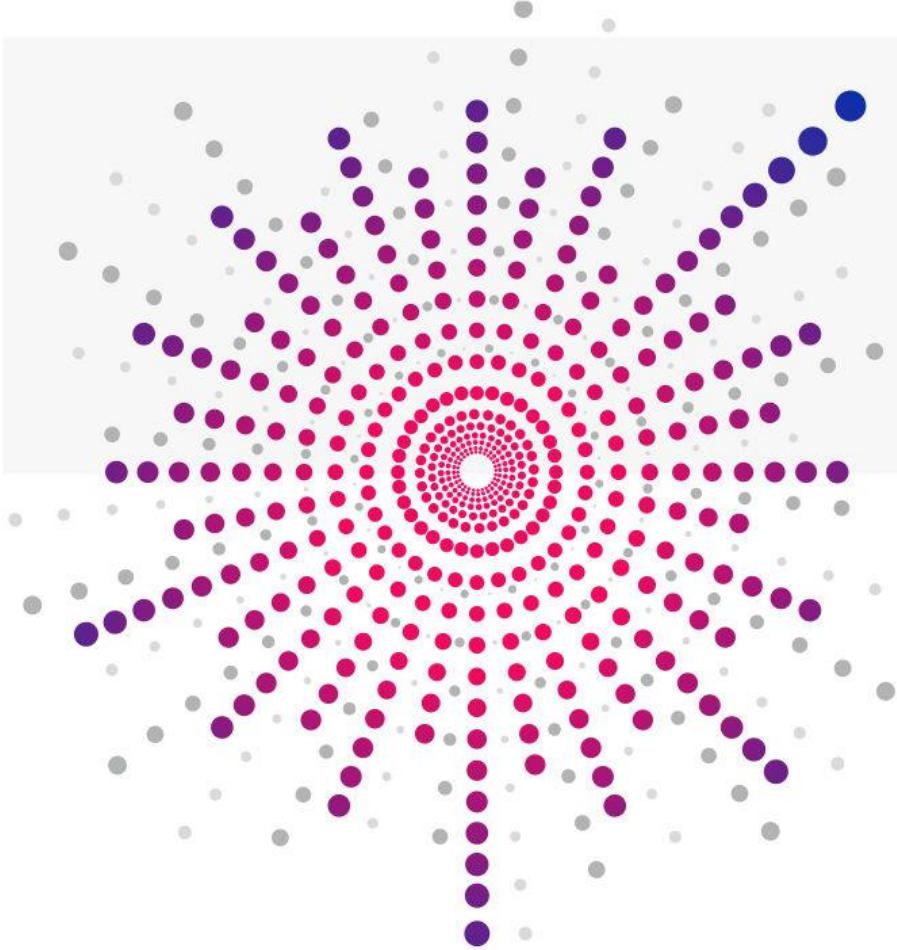




Conclusions

- ⇒ **Data democratisation**, facilitating a seamless integrated energy value chain and more efficient business processes.
- ⇒ **Energy Data Spaces**, toward a trustful and legally binding data sharing culture in the energy sector, where data value is shared and exchanged among the members of the ecosystem participants, following fair distribution of resources.





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 info@bd4nrg.eu

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**BD⁴
NRG**
Big Data for Next
Generation Energy

Thank you!

Dr Vangelis Marinakis

vmarinakis@epu.ntua.gr

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 **IEEE SmartGridComm™**

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