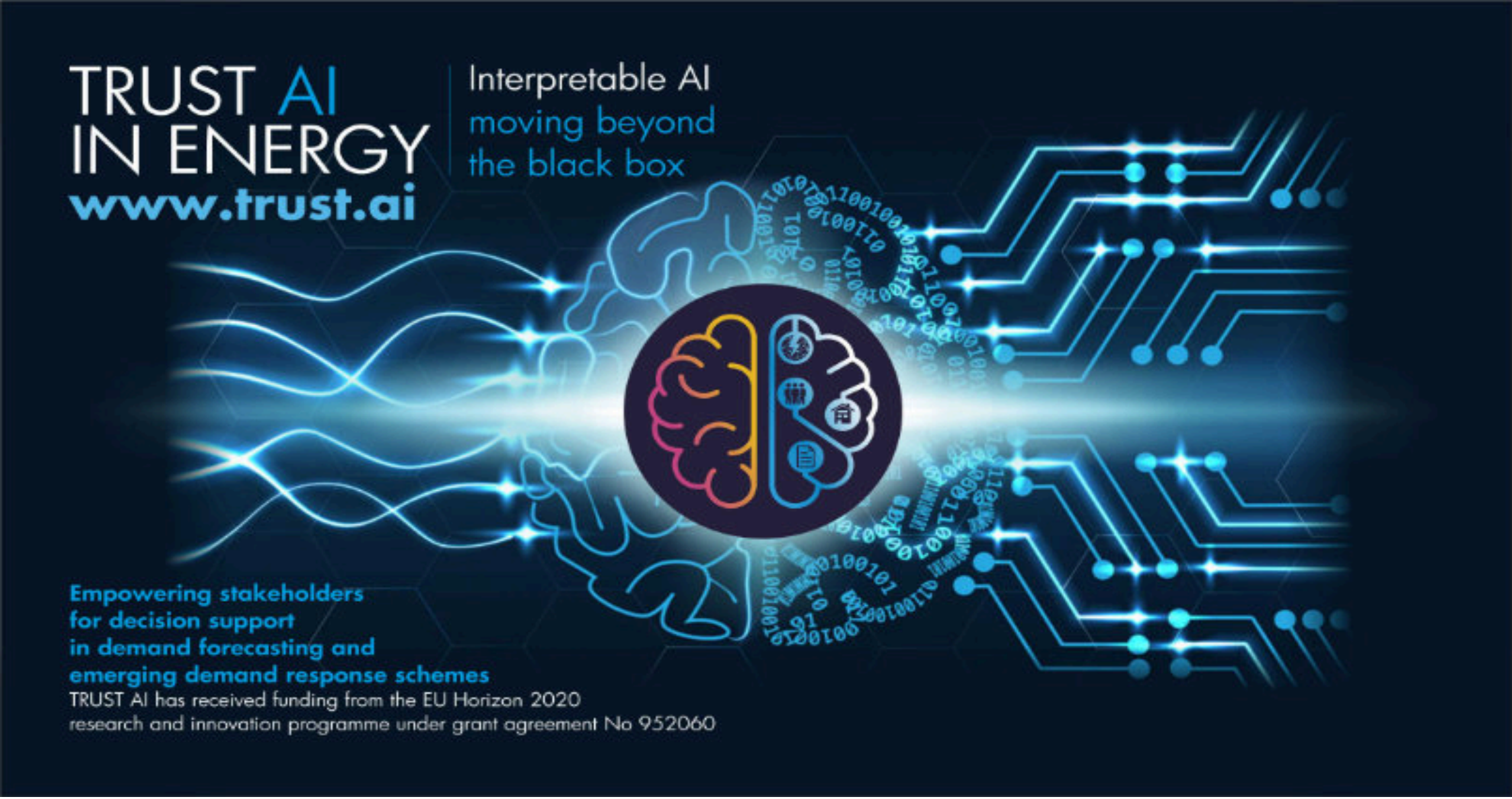


A visual white paper

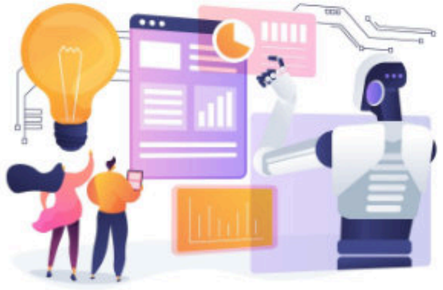
APINTECH
SUSTAINABLE SOLUTIONS FOR
THE GLOBAL COMMUNITY

TRUSTAI

1. BACKGROUND

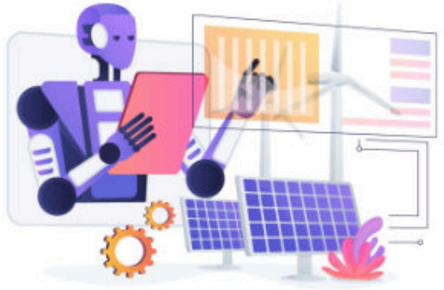
TRUST AI (www.trustai.eu) was a FET/ Horizon project that ran in the period between 2020- 2025. It delivered an explainable AI framework, based on genetic programming (GP) and symbolic expressions (SEs) that was validated in a variety of use cases from the health, energy and retail sector.

This framework is delivered under a dual license, meaning that it can be freely used and adapted for non commercial purposes.



AI-POWERED ENERGY CONSUMPTION ANALYSIS

AI-ENHANCED ENERGY GRID MANAGEMENT



AI-BASED RENEWABLE ENERGY FORECASTING

2. RESULTS

TRUST AI in Energy is an add-on that builds on TRUST AI and provides a front-end for the energy use context, allowing its users to manage their data and models without the need to engage with the details of genetic programming and symbolic expression generation which are isolated within TRUST AI. This add-on is delivered under an MIT license, meaning that it can be freely used and adapted for any purpose provided the TRUST AI license is respected.

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The add on is currently in process as we are merging in a lot of data and modeling related functionality to allow for a total isolation of the user from the TRUST AI environment, This was a key requirement validated during the interaction with thematic experts (see acknowledgments below).

3. BENEFITS

Important benefits has been defined along the below three directions:

A. Global/ model explainability

Genetic programming and symbolic expressions provide for explainable forecasting models. This means that your building energy performance is captured in an algebraic expression that allows you to have crisp insights on your building performance and how your adopted feature set will influence it. Additionally, in comparative analyses (e.g. among different buildings, or before and after a building retrofit) the energy performance change is easy to track.

Compare this with the neural network and its black box, and obscure nature!

In our research investigation and resulting published work

- We have traced no performance decline whatsoever between the obscure neural networks and explainable symbolic expressions.
- We have also found that reducing the complexity of the symbolic expression does not result in any significant decline of the performance of the model forecasting accuracy.

B. Local/ instance explainability

Feature importance and counterfactual investigations (DiCE) are seamlessly embedded in TRUST AI and accessible also as functionalities within the TRUST AI for Energy instance. A novel method for counterfactuals (CoDice) has been embedded within TRUST AI, although we have not yet used it in the instance and can not report any tangible advantages.

These features provide for what-if and related decision support scenarios. For example, how will demand change if the set-point is reduced by x deg? Again, the inherent explainability of the symbolic expressions allows one to reach an understanding of the results provided by the model.

C. Edge deployment

A third benefit is that symbolic expressions because of their compact nature can be easily moved from the cloud and ported on lean edge devices. This lends itself to the heating up discussion on AI resources and their important energy footprint.

In our case it is however not just only about resources; it is even about sheer feasibility. A neural network model is unlikely to easily fit in a simple edge device. whereas a GP model can most easily do so.

4. TIMELINE

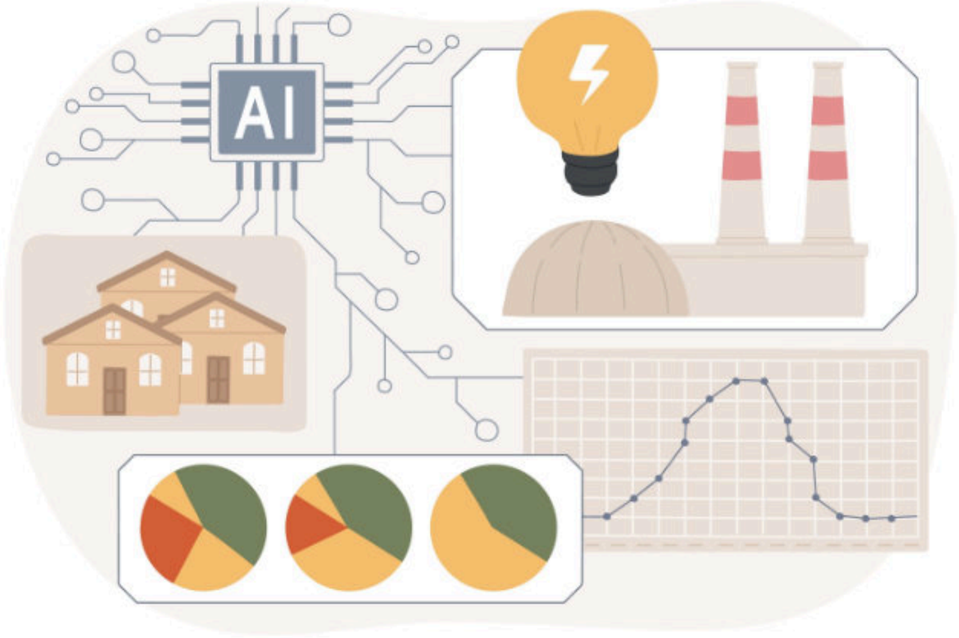
The following are currently on our workbench:

- To complete the development of the TRUST AI for Energy resource, i.e., install a separate instance of the TRUST AI framework on our servers so we can easily manage, interact and upgrade it as required (by mid 2025).
- To elaborate a feasibility study and also a prototype of a trained forecasting symbolic expression running on an edge device (end of 2025).
- To investigate how talk-to-model LLM approaches can be uptake in the solution, an area where we are coordinating with Tartu University (a TRUST AI partner) (mid term).

5. INVITATION

We would hereby wish to extend an invitation to the building energy community to

- Reflect on the above and possibly other benefits of genetic programming (GP) and symbolic expressions and interact with us (see item 8 below) also in pursuance of potential joint activities
- Engage with our TRUST AI in ENERGY instance when it will be announced (expected by mid 2025)
- Our validation was restricted to a single building; though results were promising in terms of accuracy there is obviously a need for scaling up validation. Multi User environments (e,g. an energy community) could provide valuable insights.
- Likewise, we believe these novel approaches can provide an exciting stimulus for researchers working in energy and, in particular, building energy modeling.



6. ACKNOWLEDGMENTS

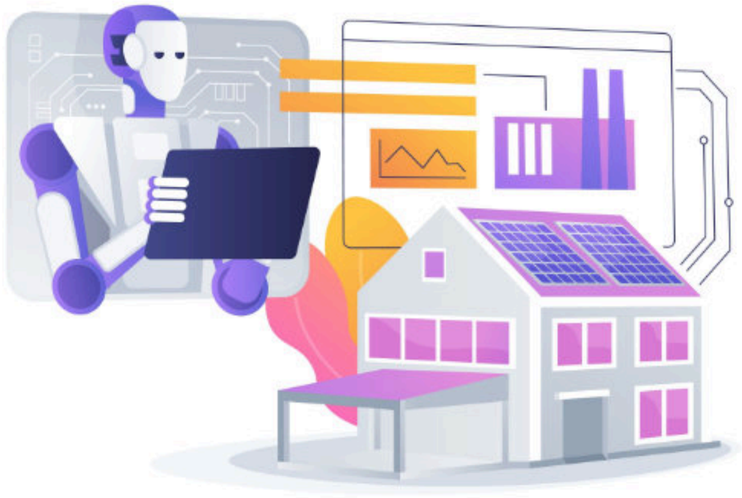
We would hereby wish to extend our thanks to Dr. Stavros Hadjiyiannis (IoT Manager, Cyric, CY), Mr. Alfio Galata (building energy expert, independent contractor, IT), Mr. Chris Moutoulas (building technology services provider, GR), Prof. Nikos Zarkadis (Professor of Building Technologies, HESGE, CH), for their multi-fold inputs and assistance.

7. RESOURCES

The scientific documentation of our approach can be found here. Several publications are listed there, on genetic programming and symbolic expressions.

If you are interested only on the energy related ones, you can use the filter on the left column.

Also, data and models are shared on xenodo and are accessible here.



8. CONTACT US

Our linkedin page will serve as the communication gateway on all related developments. Alternatively you can reach us at info@apintech.com.

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