EURIPIDES² Penta

CO-LABEL

PROJECT IMPACT

2021028

ECOMAI

ECOMAI showed that electric motors with embedded AI control systems can reduce energy consumption and improve availability through predictive maintenance.

January 2026

Electric motors move our daily lives in laptop fans and in our cars. But all the positive effects have an ecological impact, because electric motors are responsible for CO_2 emissions. Motor failures and unexpected downtime cause economic damage. Optimising the service life of electric motors therefore enables positive changes in terms of environmental safety and economic growth.

Achievements and results of the project

A specialised Edge AI silicon hardware platform with AI compiler, a development kit for modelling use case systems and a model-based design environment for an AI-enhanced engine system were created. Test environments for electrical motor control applications utilise AI extensions. Dynamic load changes and fault-induced scenarios for the development of AI models could be analysed. An AI-enhanced ultrasonic transducer for live measurement of the complex driving signal makes it possible to test predictive maintenance. This provides an easier entry point for SMEs into such technologies.

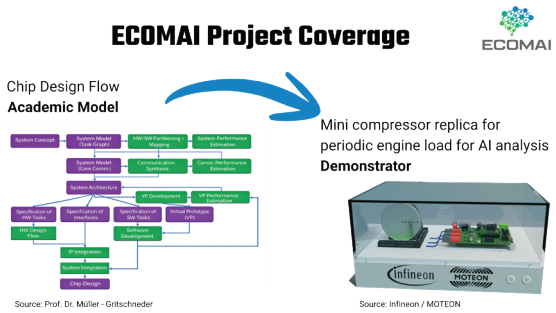

Figure 1: The ECOMAI Project Coverage

Background, objectives of the project and challenges

The ECOMAI project developed technologies that improve electric motor drive systems with an embedded AI system running on a specialised AI hardware platform. One goal was to create ecological electric drives for green systems with lower energy consumption. Another focus was to reduce the downtime of transport systems and machines through predictive maintenance. The third goal was to achieve a longer lifetime of drive systems through improved maintenance. The ECOMAI project coverage and its value chain included the whole span from an academic model to the demonstrator of the solutions. The model for the chip design flow was based on the research of the academic project leader Prof Dr D. Müller-Gritschneder. The demonstrator on the right in Figure 1 is a result of the research / doctoral thesis of Steven Klotz from Infineon. The demonstrator, developed in collaboration with MOTEON, impressively shows how the use of AI leads to more reliable and safer systems.

Six use cases were identified in three technical areas that addressed current problems and market requirements. The area, predictive maintenance, comprised the “Platform Screen door” use case by Albayrak and the “Ultrasonic based condition Monitoring” use case by usePAT. The use cases from MOTEON “Automotive Compressor System” and neuroConn “Rehabilitation Robot System” were located in the area of ecological electric drives. In the area of AI-supported control for energy-efficient drives, Infineon dealt with the use cases “Initial Motor Control Tuning” and “Filed Motor Control Tuning”. Overall 13 KPIs were defined to measure the improvement due to the project outcomes. As two key KPIs of the project. it was shown that the energy consumption of motor control can decrease between 0,65% and 4% depending on the application (FEAAM). Additionally, availability through predictive maintenance (Albayrak) was improved by 0.5% (from 99.4% to 99.9%).

Technological achievements

ECOMAI brought together expertise from partners ranging from hardware design, edge AI, AI applications, electrical motor drive system design and predictive maintenance to address the project's ambitious research challenges.

The innovative **Specialized Edge AI Hardware Platform with AI Compiler** (Figure 2) is plugable with existing boards, firmware compatible and is a realistic industrial design. The platform was taped out in silicon. Innovative is the Offline-capable Hardware abstraction layer (HAL) – common library for compiler and "conventional" usages. An Improved disturbance rejection at reduced energy demand was shown with the Tiny Reinforcement Learning Agent in simulation.

A Development Kit and Model-based Design Environment for AI-enhanced Motor System using Enterprise Architect´s - IoT-PML extension to model Use Case Systems was developed.

For Ecological Control an **AI Enhancement for Electrical Drive Systems** was developed. The Test environment dynamic load change motor control application was built up by MOTEON/Infineon (Figure 4). **The Electric Traction Drives Testbench Demonstrator** was shown by FEAAM (Figure 3). An overall 0,65% energy saving on real test system compared to a highly optimized baseline was achieved.

The **test environment for upper limp training system** to control in MedTech area was implemented by neuroConn.

One more result is the **Predictive Maintenance System** (Figure 5) for PSD/Platform Screen Doors. A test platform with fault induced scenarios for AI model development to test the predictive maintenance use-case was set up by Albayrak. The Availability rate was improved to 99,8%. An **AI-enhanced ultrasonic transducer** to live measure the complex electrical admittance of the driving signal was developed by usePAT.

The **Lower Entry way for SMEs into AI-Enhanced Motor Drive Technology** was Evaluated by SME partners qualitatively on use cases. The SMEs adopt AI technologies and modelling methodology.

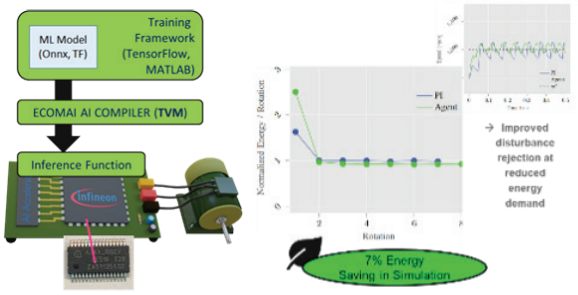

Figure 2: ECOMAI AI Chip + AI Compiler (left) and tiny Reinforcement Learning Agent (right) (Source Infineon).

Figure 3: PMSM Motor Control (source FEAAM)

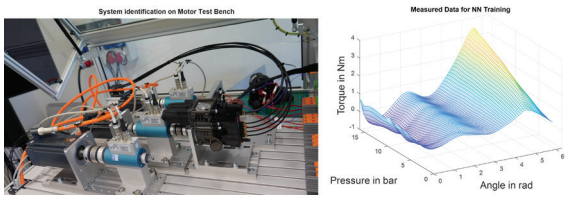

Figure 4: Ecological Motor Control: Feed Forward Neural Network to Handle Load (source MOTEON)

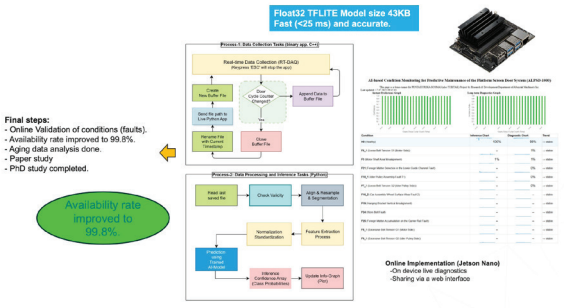

Figure 5: Predictive Maintenance (source Albayrak)

EURIPIDES² Penta

CO-LABEL

KEY APPLICATION AREAS

- Digital Industry
- Mobility
- Quality, Reliability, Safety and Cybersecurity

ESSENTIAL CAPABILITIES

- Architecture and Design: Methods and Tools
- Artificial Intelligence, Edge Computing and Advanced Control
- Components, Modules and Systems Integration

PARTNERS

Infineon Technologies AG (Infineon)
MOTEON GmbH (MOTEON)
neuroConn GmbH (neuroConn)
FEAAM GmbH (FEAAM)
Technische Universität München (TUM)
Technische Universität Ilmenau (TUIL)
Sparx Systems Software GmbH (SPARX)
usePAT GmbH (usePAT)
ALBAYRAK Makine Elektronik Sanayi ve Ticaret A.Ş. (Albayrak)

COUNTRIES INVOLVED

Austria
Germany
Turkey

PROJECT LEADER

Fabiola Bermudez-Elsinger
Company : Infineon

KEY PROJECT DATES

Start: 01 May 2022
End: 30 September 2025

Market Potential

The results of ECOMAI have the potential for significant market impact, as only a few motor and drive systems provide AI-enhancements at the drive control level right now. The market of AI chips, motor control chips and in general of motor systems is predicted to grow fast as electrical motor and drive systems basically form the basis of any modern system with movement. Relevant markets for ECOMAI are the artificial Intelligent Chips with a CAGR of 36,6%, Microcontrollers with a CAGR of 9,93%, Motor Control Chips with a CAGR of 7,82% and Electrical Drive Systems and Predictive Maintenance with a CAGR of 8%.

ECOMAI | Figure 6: Embedded World Conference and Exhibition: Bringing it all together 11.-13.03.2025 (source: Steven Klotz

Societal & Economic Impact

The environmental impact of electric motors is significant, as they are responsible for 40% of global electricity consumption and 20% of CO_2 emissions. Optimising the lifetime of electric motors means positive changes for environmental safety and economic growth. The social impact contributes to environmental protection. Applying the latest AI technology will keep the EU competitive by making it easier for SMEs to access AI-based drive technology. This means strengthening the innovative power of SMEs, which account for more than half of the turnover in the European economic area.

Patents, Standardisation, Publications

One highlight was the participation in the Embedded World Conference and Exhibition from 11 to 13 March 2025 (Figure 6). All results were summarised.

The dissemination activities were varied and contributed to the level of awareness of the project results. Eight master's theses, one doctoral thesis and one bachelor's thesis have been achieved. The results were presented in 7 scientific papers and 4 conference papers. One special honour was the Best Paper Award.

ECOMAI also received the PENTA Innovation Award 2025.

Future Developments

The innovative approaches in ECOMAI are an important step in expanding the product portfolio in terms of differentiated cost-optimised solutions. The skills acquired will be utilised by customers with similar use cases. The experience gained with AI applications will flow into further projects at the partners. New service offerings will be created in the healthcare sector, among others. Training programmes will be set up at universities and jobs created.

AENEAS Office
44 rue Cambronne
F-75015 Paris - France
Tel. +33 1 40 64 45 80
Fax +33 1 40 64 45 89
euripides@euripides-eureka.eu
penta@aeneas-office.org