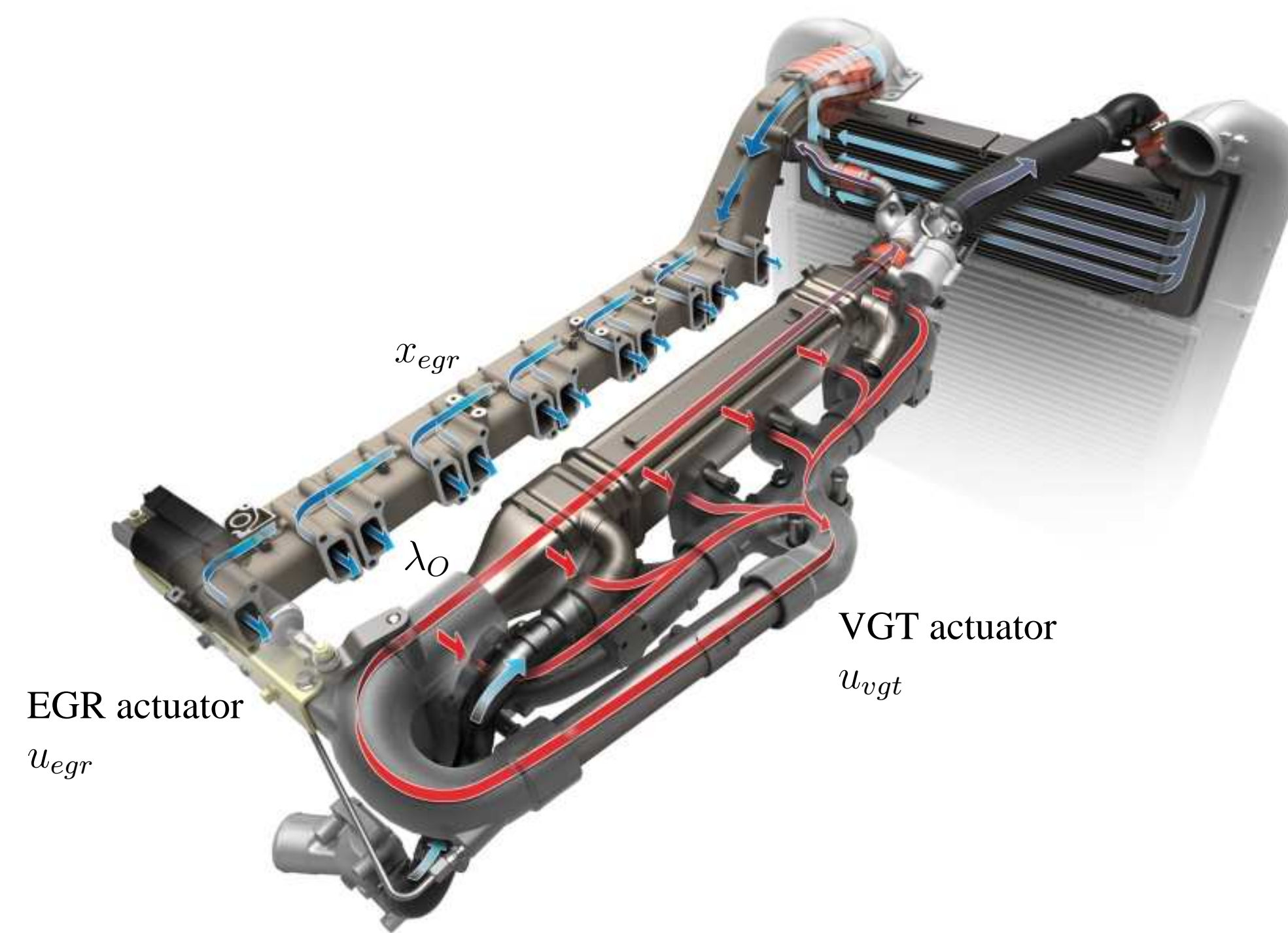


Background

Overall goal:

- Fulfill legislated emission limits (smoke and NO_x)
- Optimize fuel consumption (pumping work)
- This requires: coordinated control of Exhaust Gas Recirculation (EGR) and Variable Geometry Turbine (VGT)



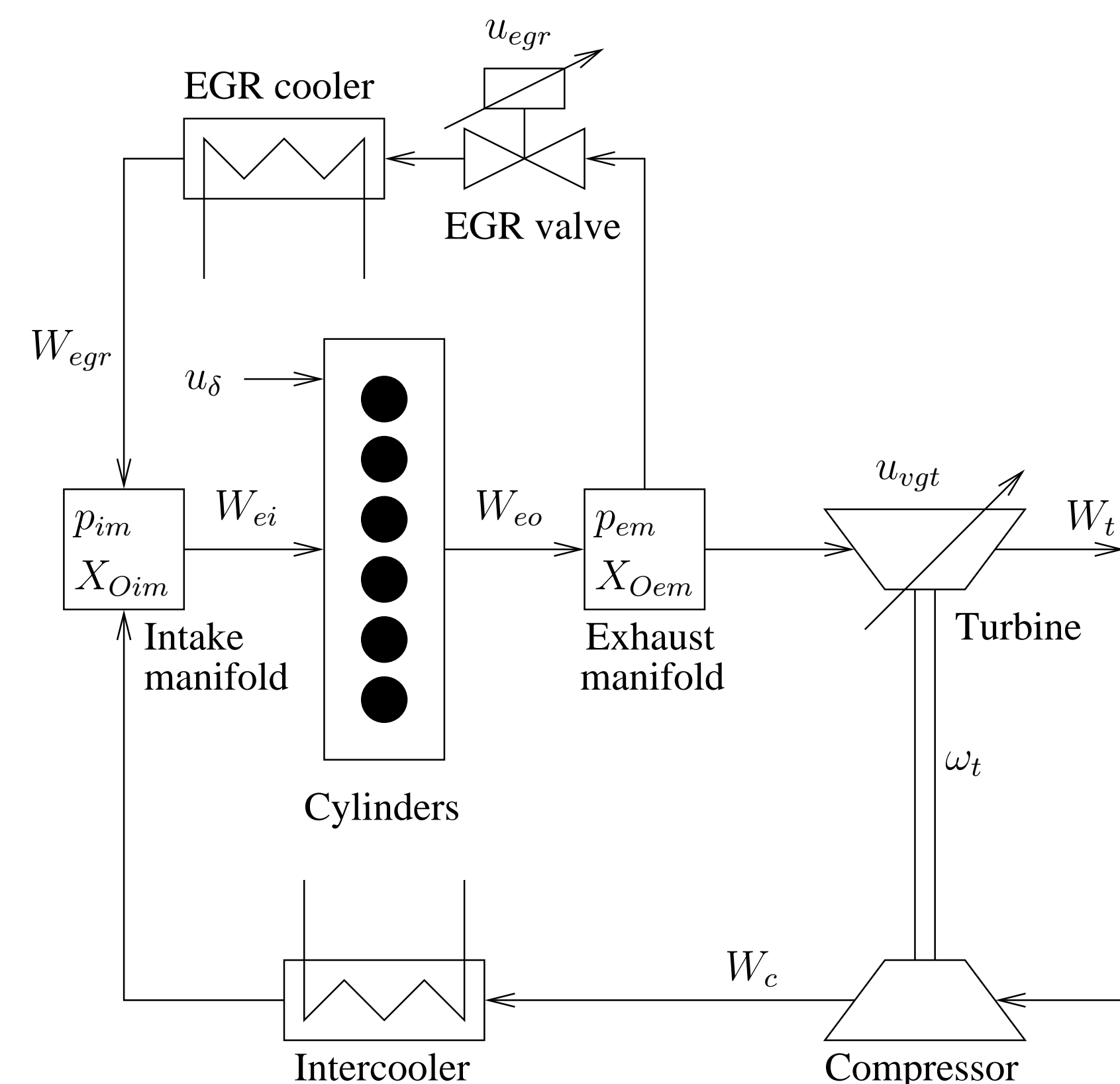
Main performance variables:

- Oxygen-fuel ratio λ_O
- EGR-fraction x_{egr}

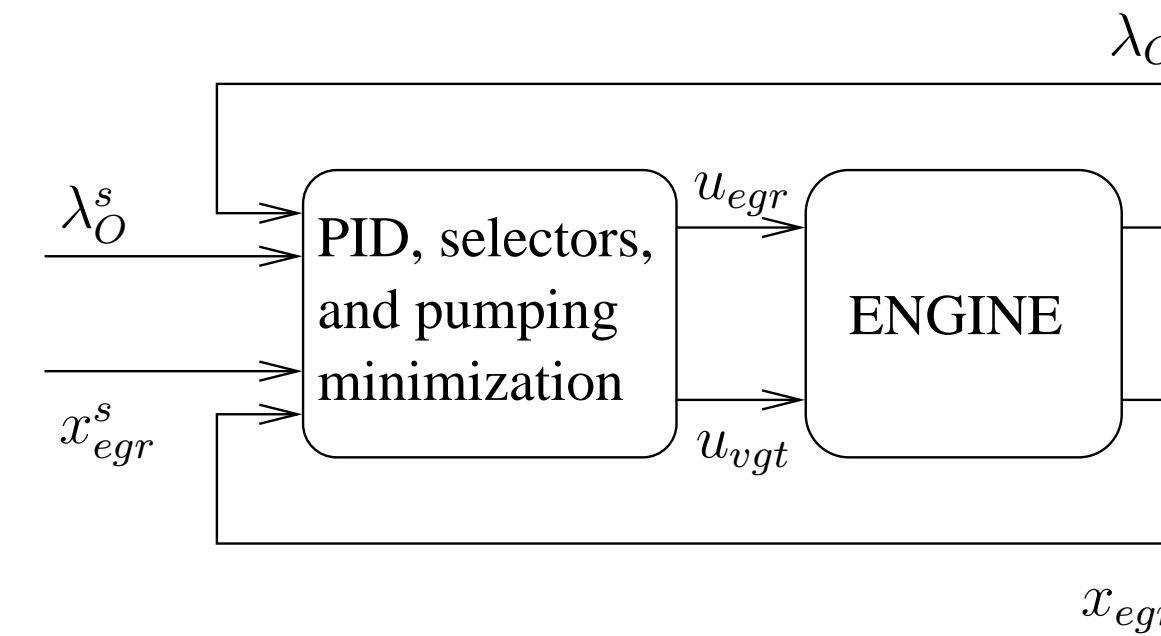
Motive: Strongly connected to emissions

Modeling

A model of gas flows in a diesel engine is developed for system analysis, simulation, and development of model-based control systems

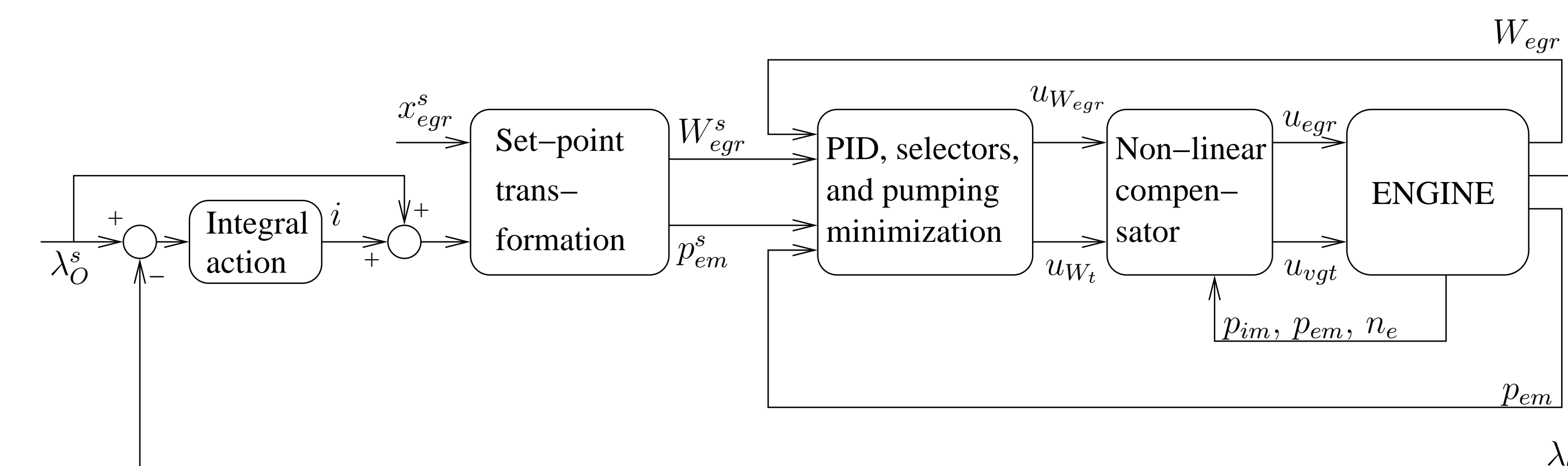


Controller 1: Pumping Minimization



- Consists of PID controllers, min/max-selectors, and a pumping minimizing mechanism
- Controller 1 reduces the pumping work with 21% compared to the current production controller, yielding 1.4% less fuel consumption

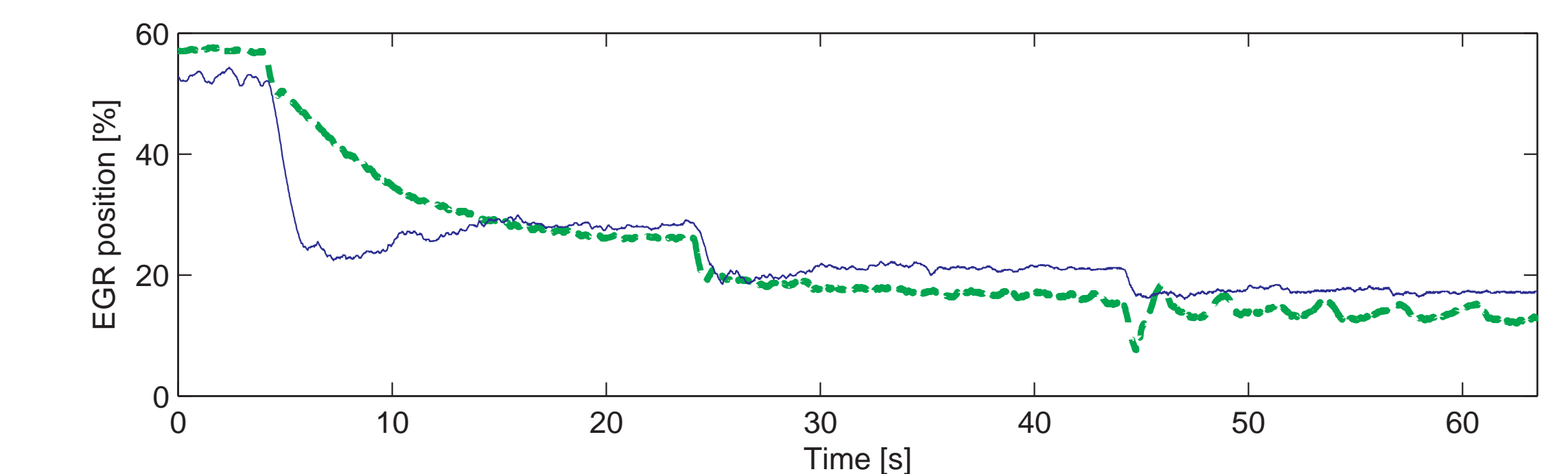
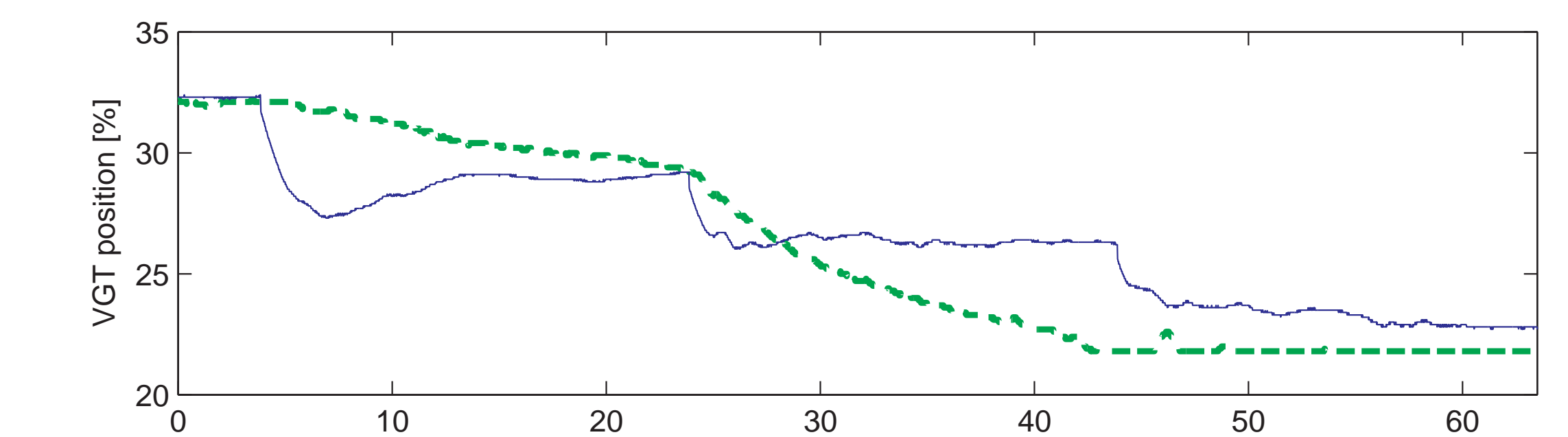
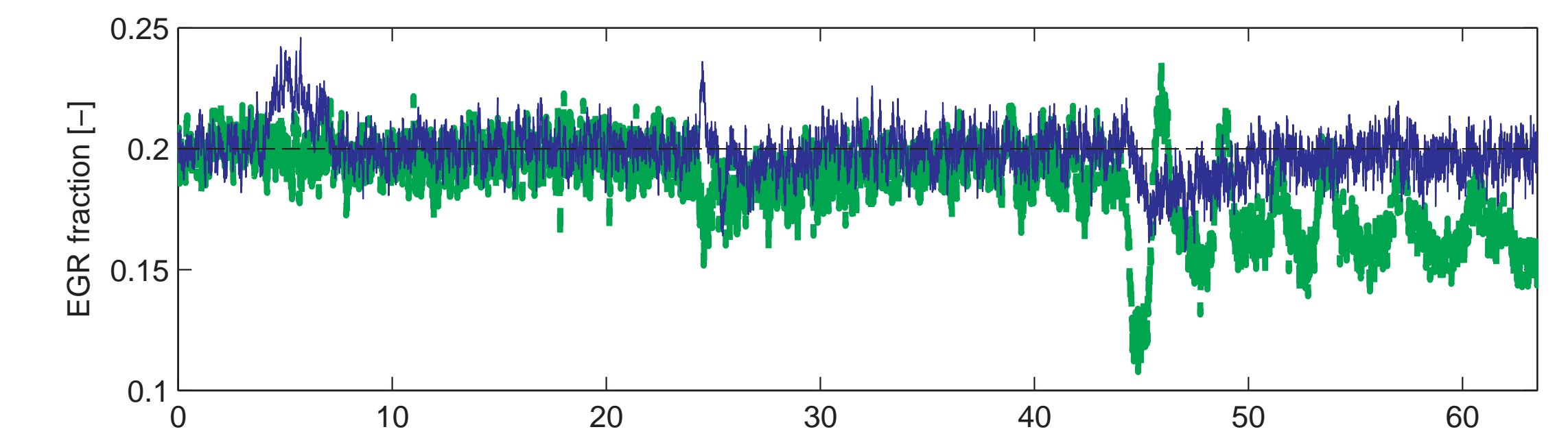
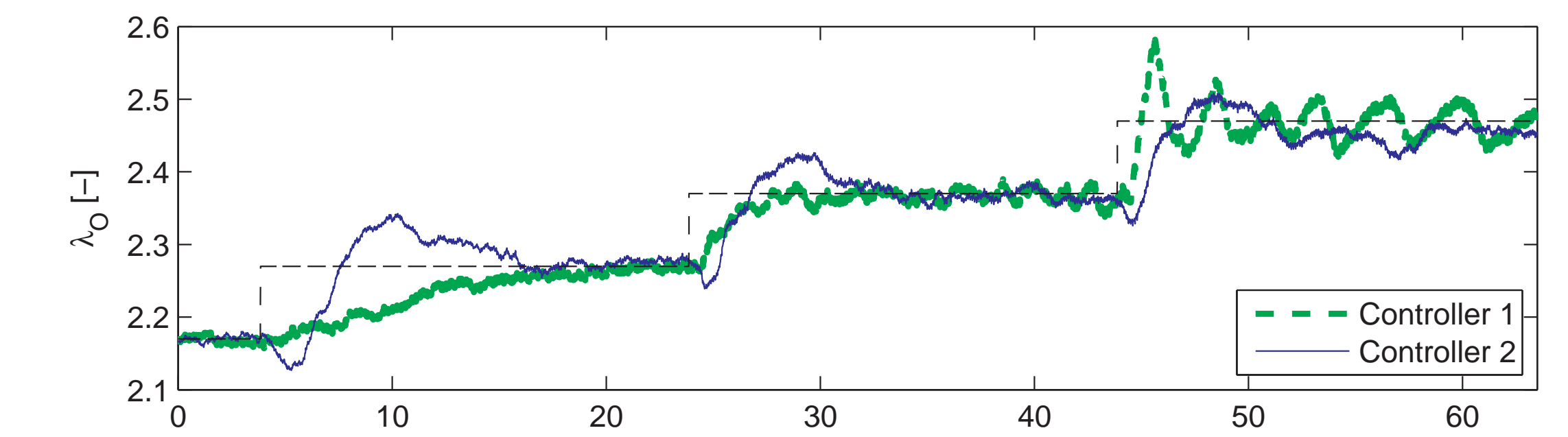
Controller 2: Non-linear Compensator



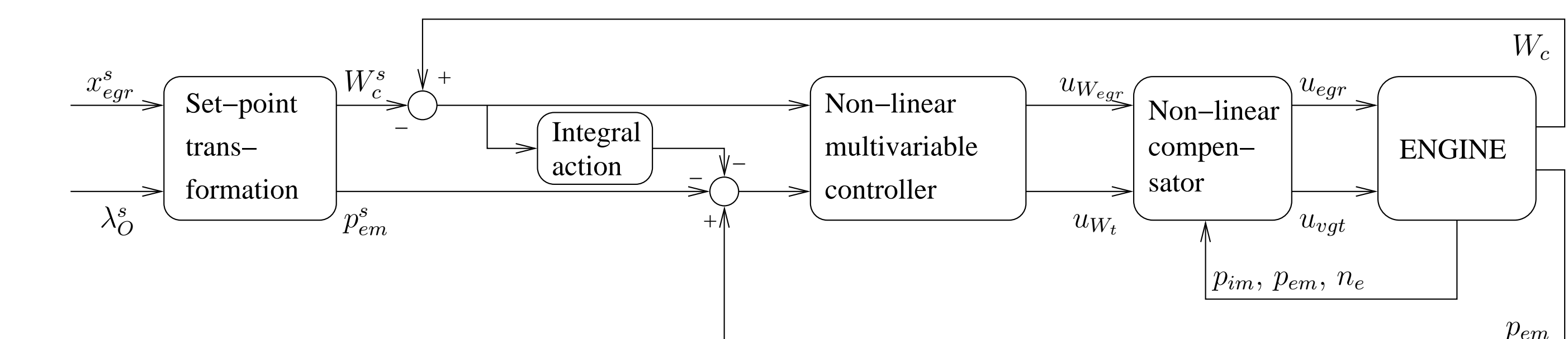
- The diesel engine has significant non-linear effects
- To handle these effects, a non-linear compensator is investigated
- Non-linear compensator: a nonlinear state dependent input transformation that is achieved through inversion of the models for EGR-flow and turbine flow
- The set-points for the performance variables are transformed to the set-points for the feedback variables
- To handle model errors in this set-point transformation, an integral action on λ_O is proposed in an outer loop

Experimental Results

- Controller 2 improves the performance compared to controller 1 and controller 2 achieves the same step response for different flow conditions, thus handling the non-linear effects



Controller 3: Non-linear Control



- The PID controllers are replaced by a non-linear controller
- Based on a Lyapunov function and inverse optimal control

Results from comparisons between controller 2 and 3:

- It is important to use the non-linear compensator and it is sufficient to use controller 2 to handle the non-linear effects
- Controller 3 is sensitive to model errors in the non-linear compensator while controller 2 handles these model errors