Modeling Pedal Electric Bike's Electric Motor Support with Simulink

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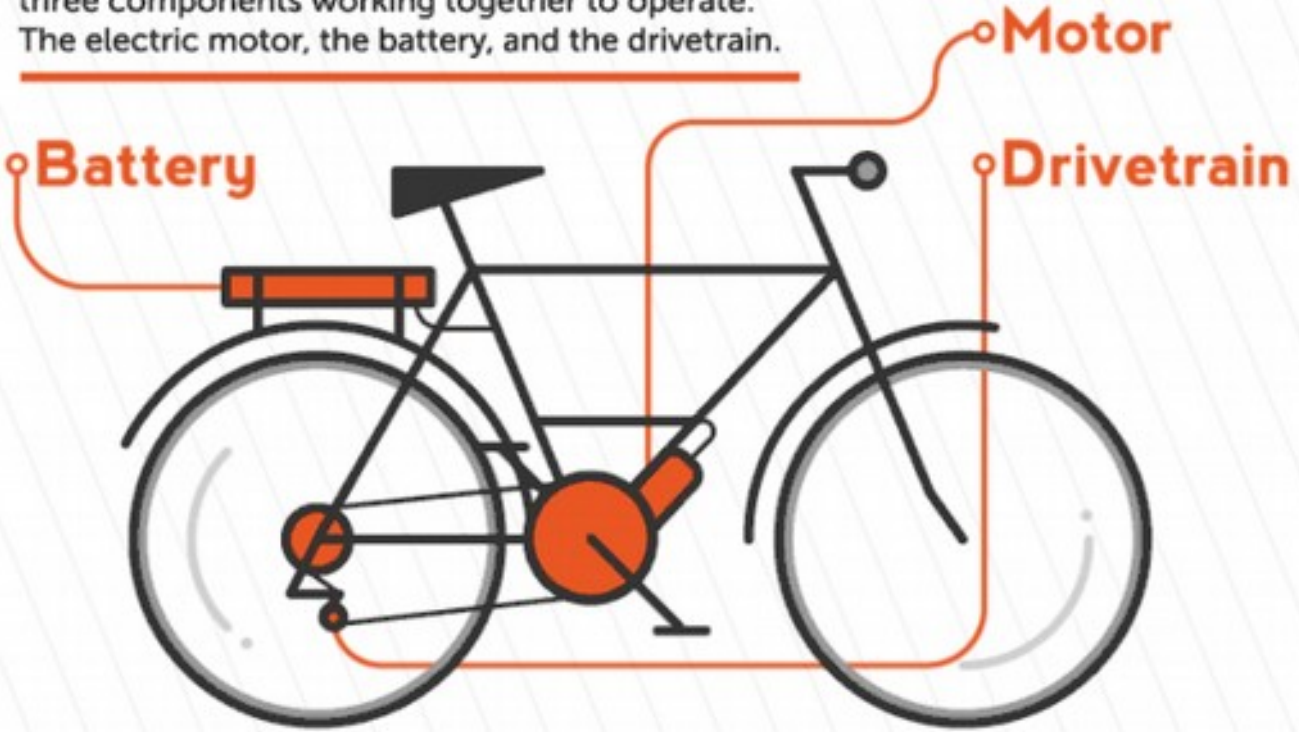
Embedded Systems Master Program

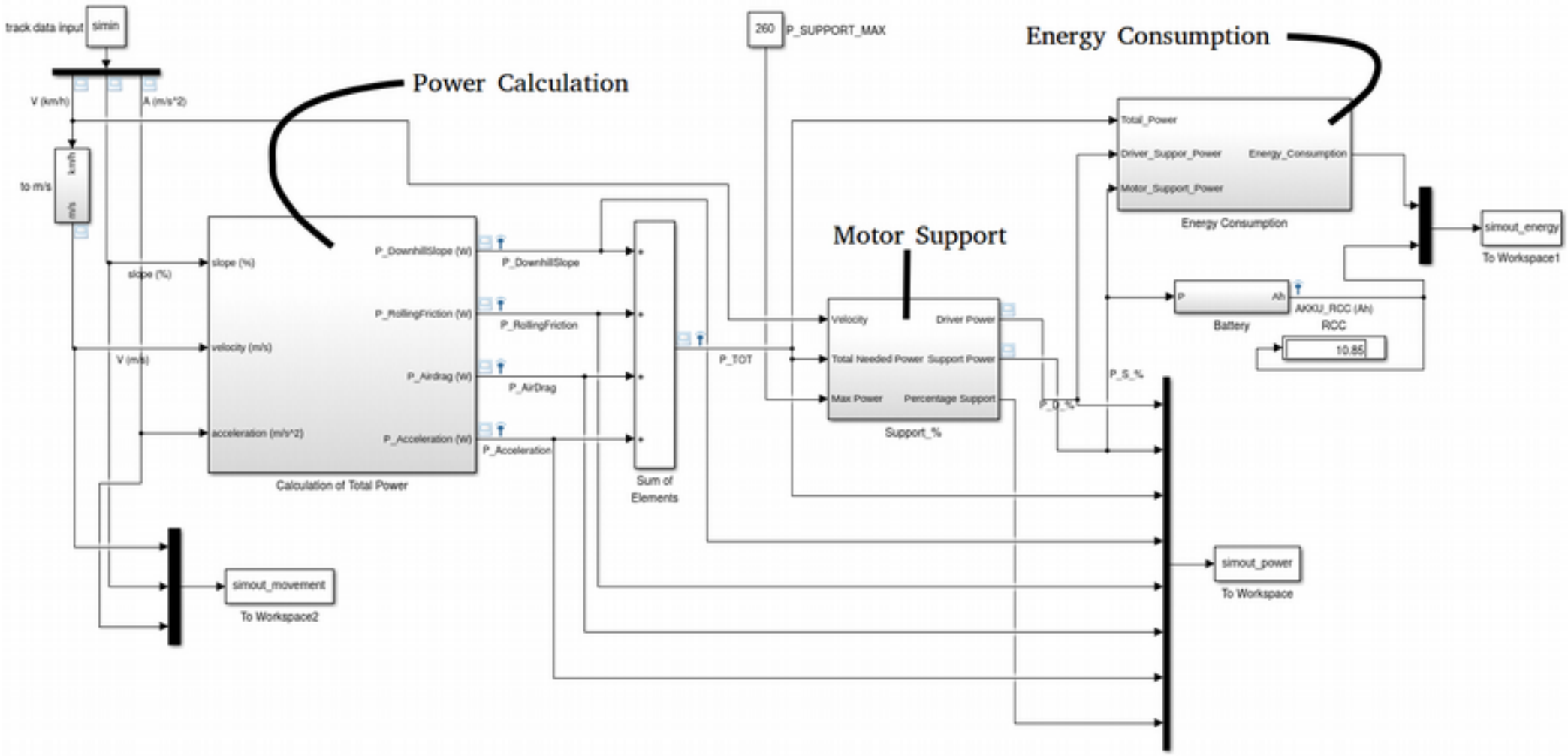
HOW ELECTRIC BIKES WORK

Three Main Components

Electric bicycles are like regular bikes, but rely on three components working together to operate: The electric motor, the battery, and the drivetrain.

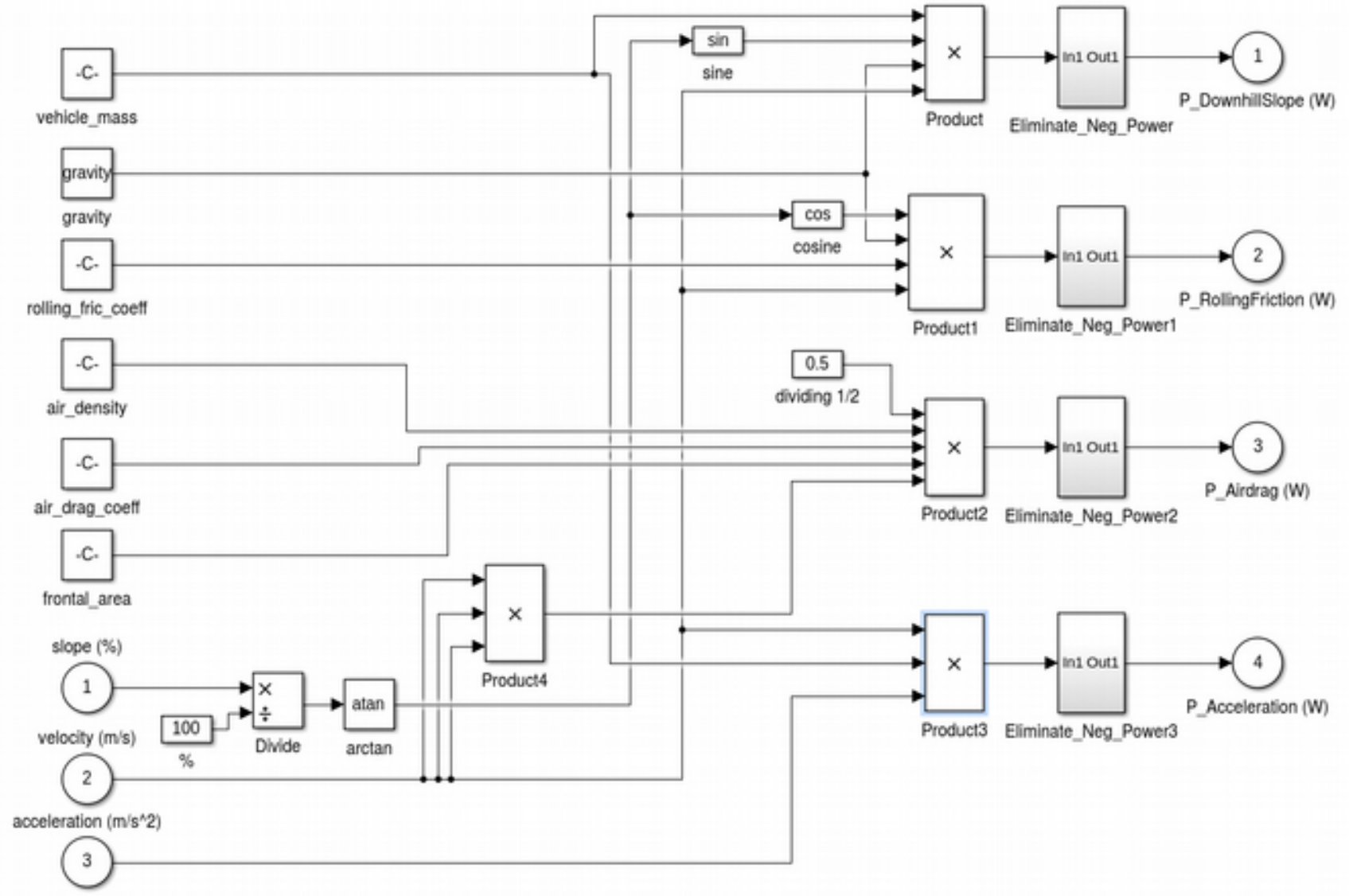


Simulink Model of Pedelec

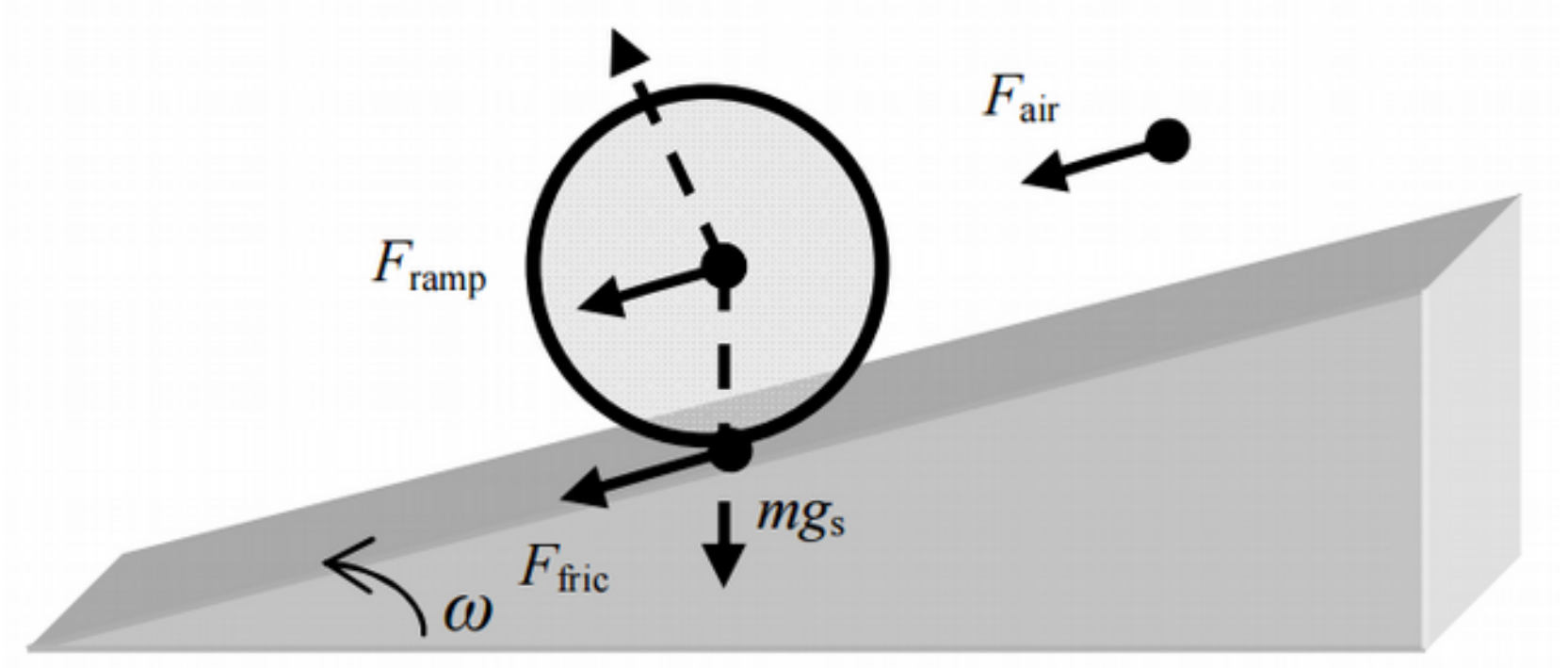


Power Calculation Subsystem

$$P_{Pedelec}(s_i) = P_{Acceleration}(s_i) + P_{RollingFriction}(s_i) + P_{DownhillSlope}(s_i) + P_{AirDrag}(s_i).$$

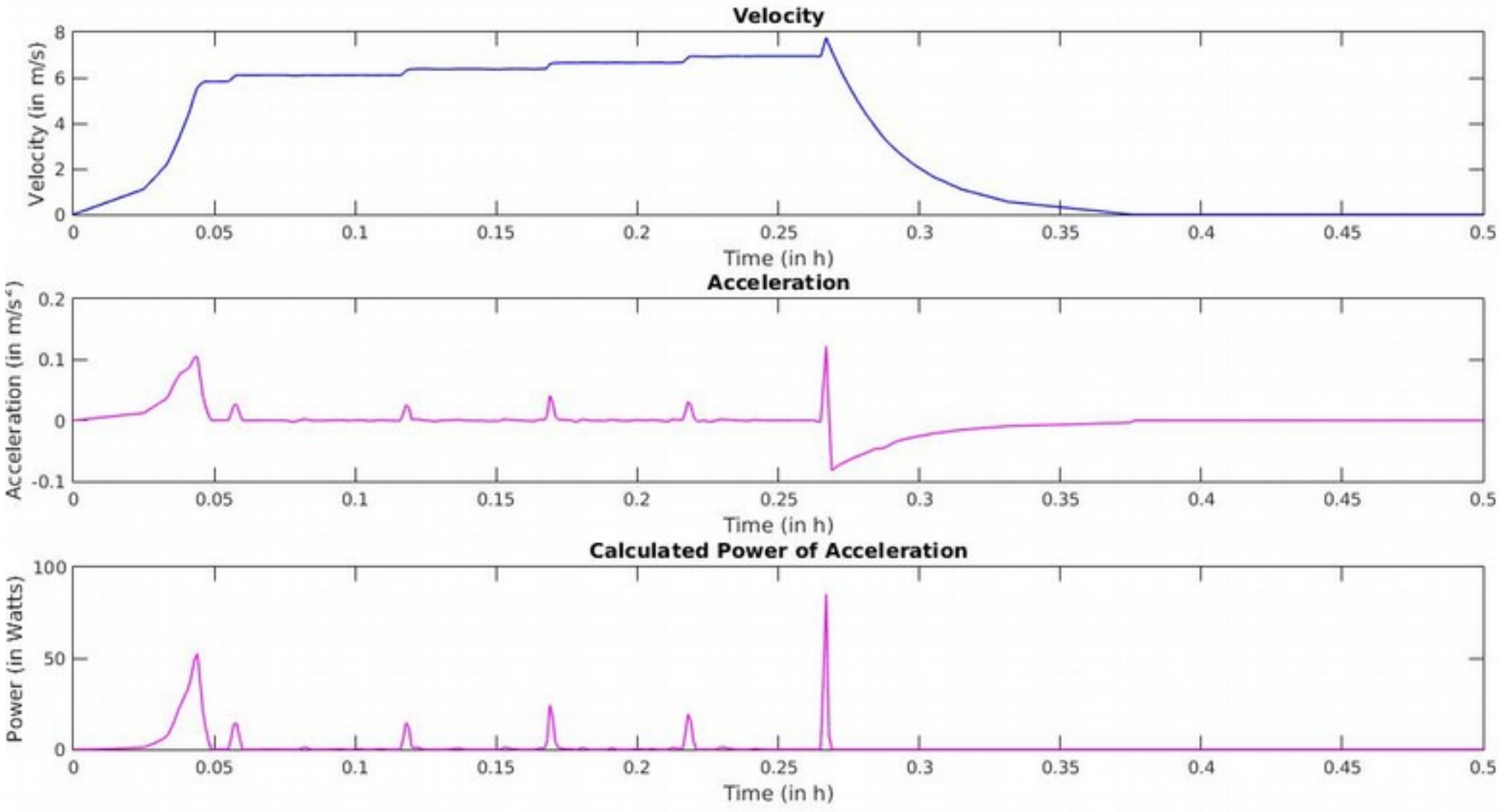


Uphill Motion



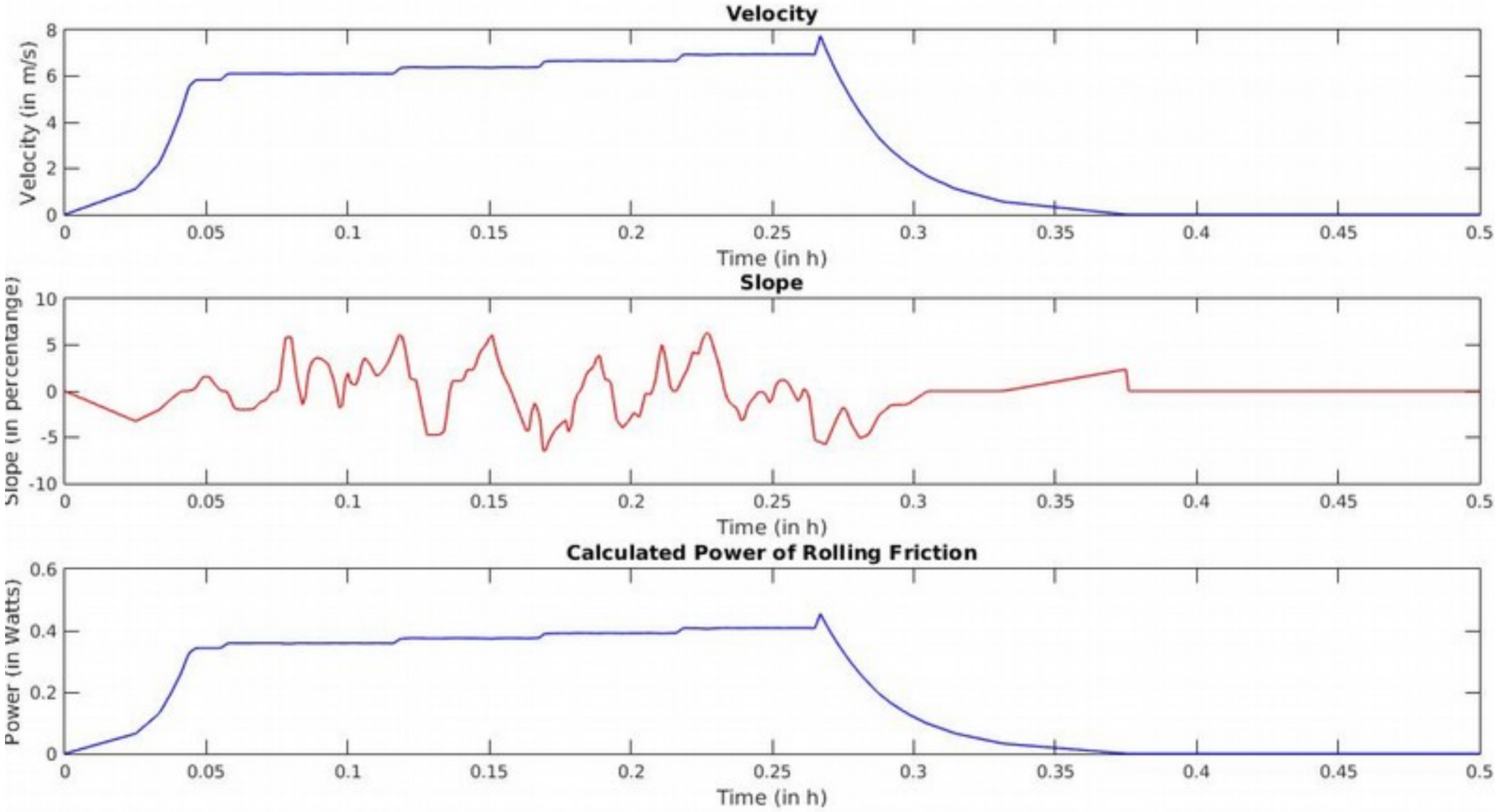
Power for Acceleration

$$P_{Acceleration}(s_i) = a_i \cdot (m_{Pedelec} + m_{Driver}) \cdot v_i$$



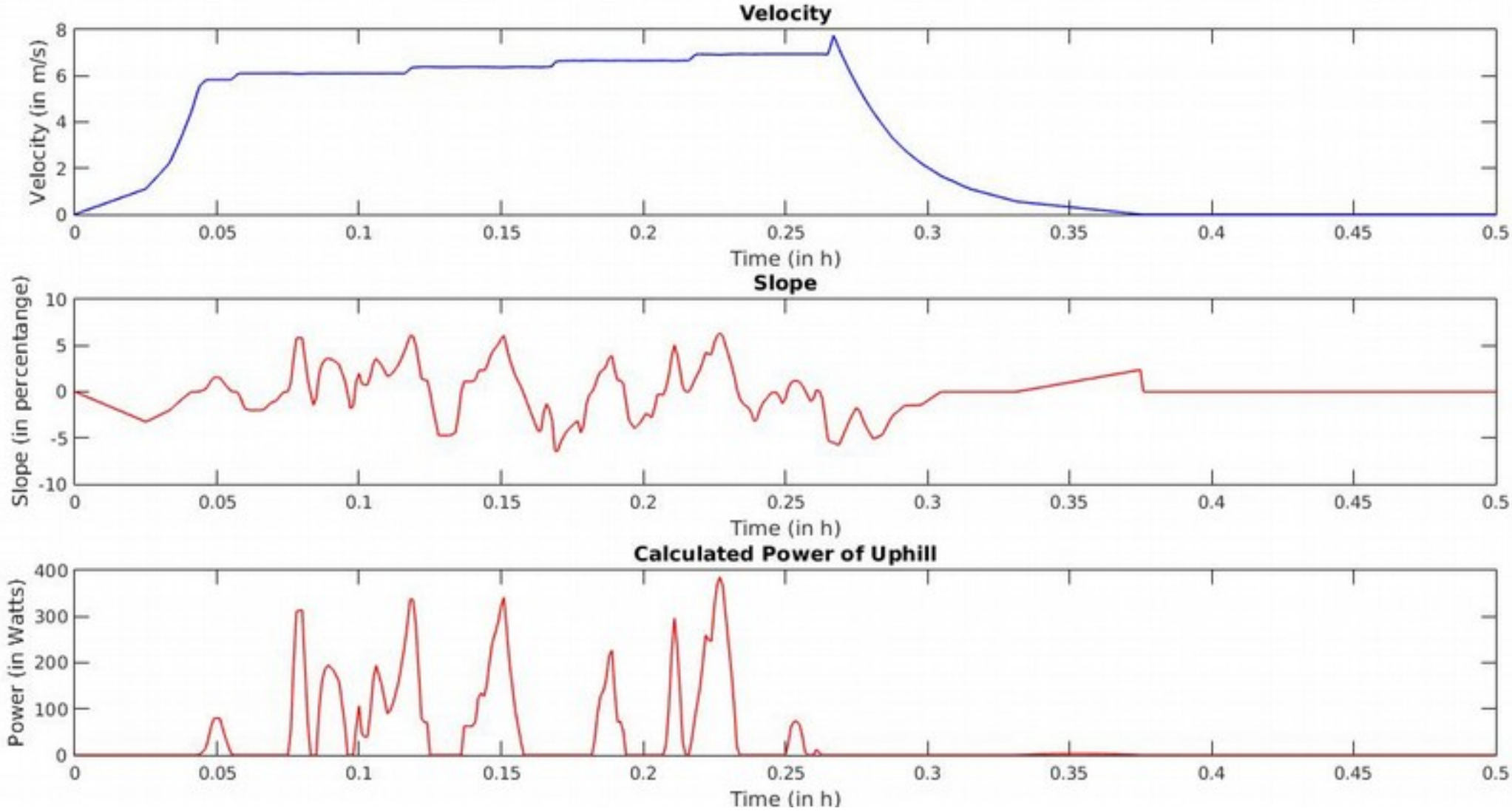
Power for Rolling Friction

$$P_{RollingFriction}(s_i) = c_r \cdot cos(\alpha_i) \cdot g \cdot (m_{Pedelec} + m_{Driver}) \cdot v_i$$



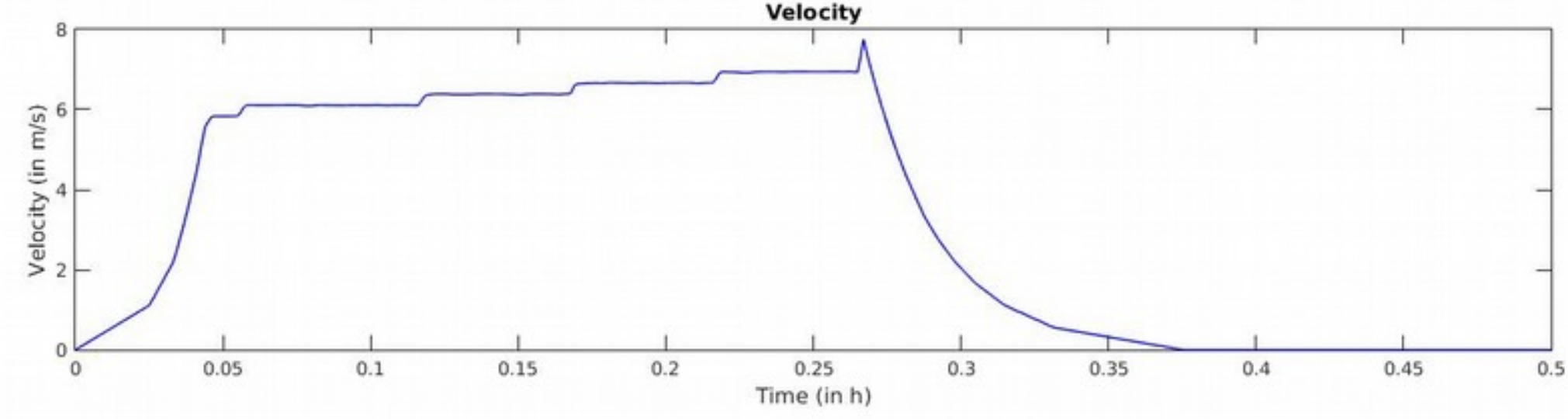
Power for Uphill !

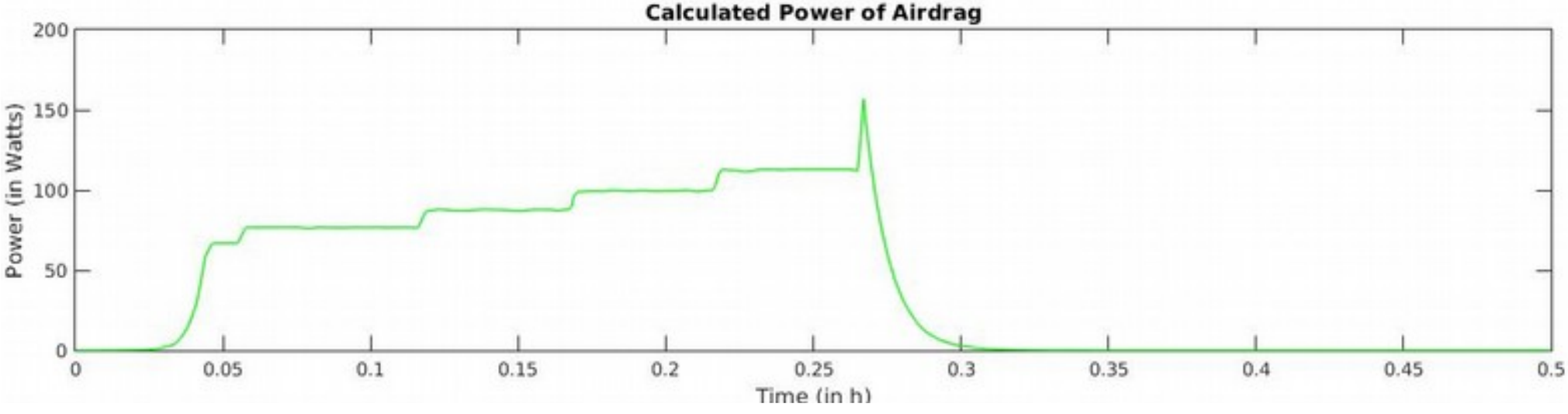
$$P_{DownhillSlope}(s_i) = sin(\alpha_i) \cdot g \cdot (m_{Pedelec} + m_{Driver}) \cdot v_i$$



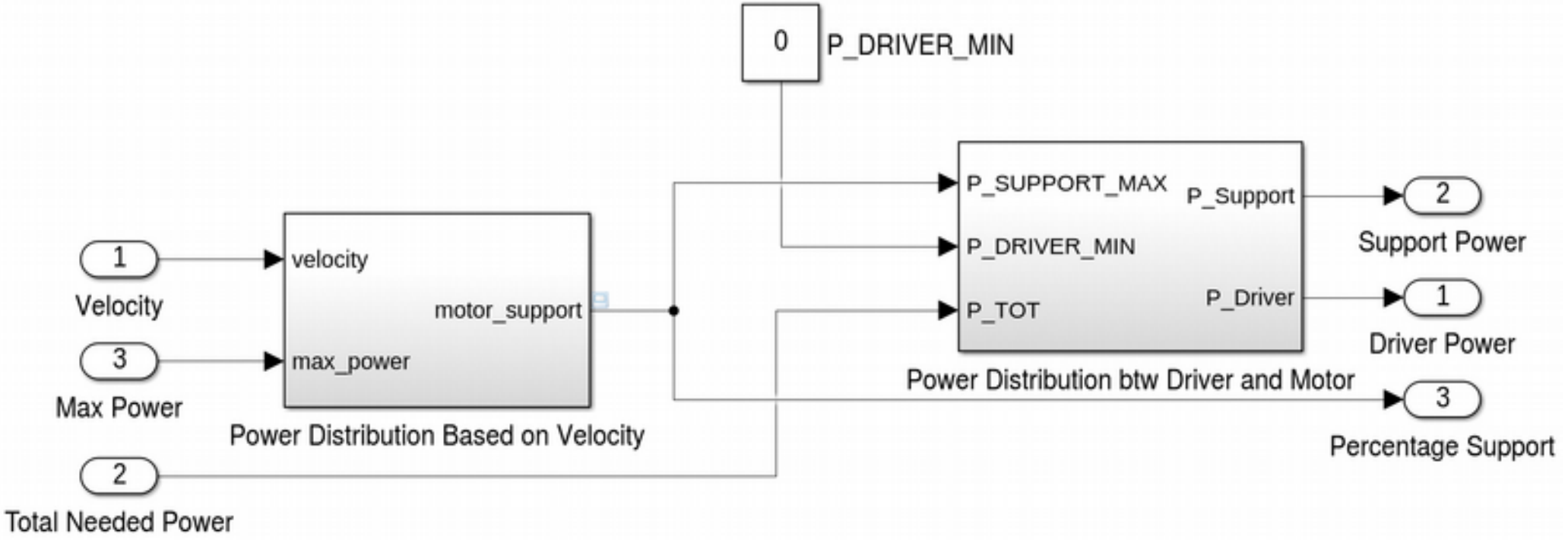
Power for Air Drag

$$P_{AirDrag}(s_i) = \frac{\rho \cdot c_w \cdot A \cdot v_i^2}{2} \cdot v_i$$

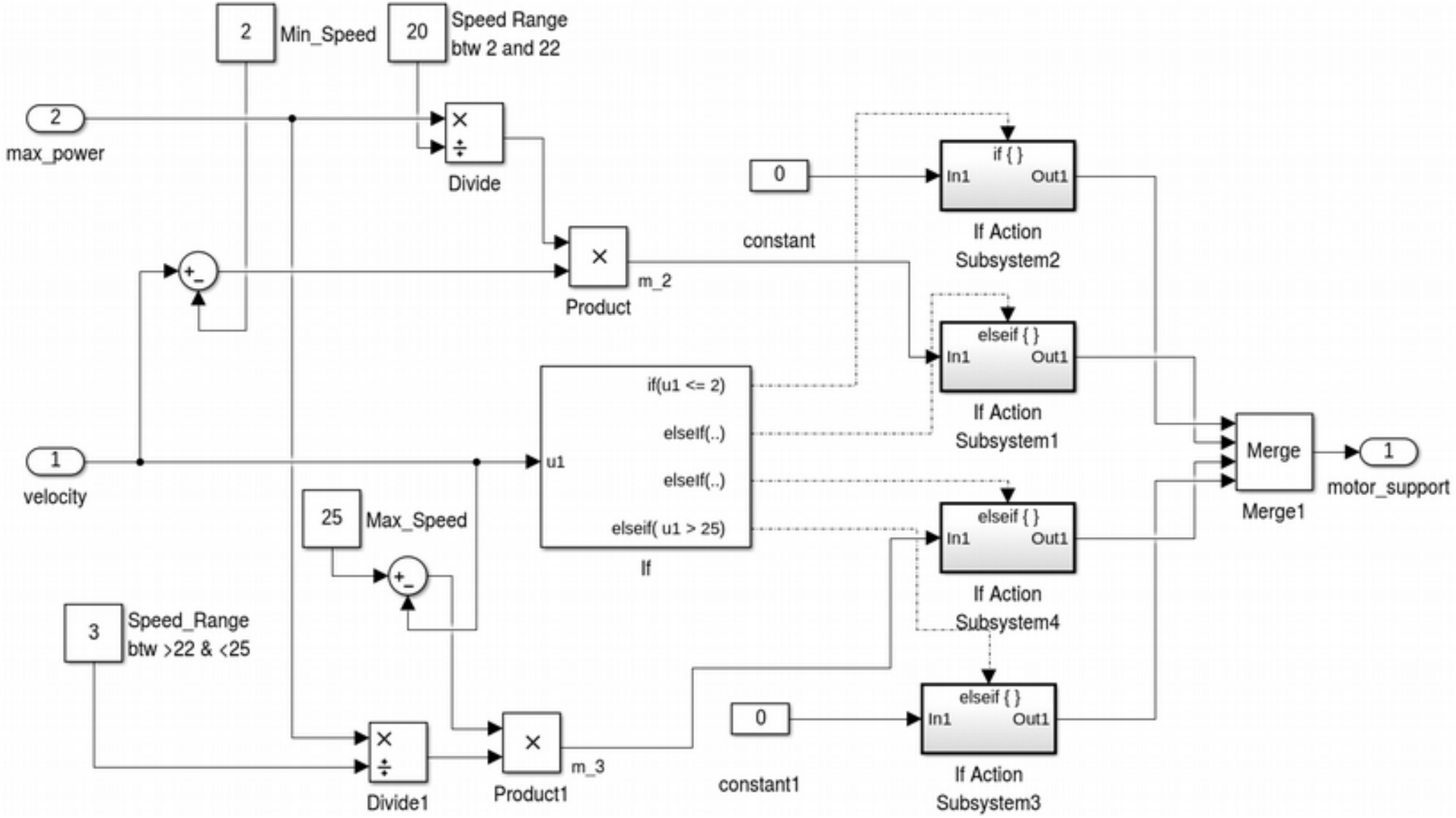




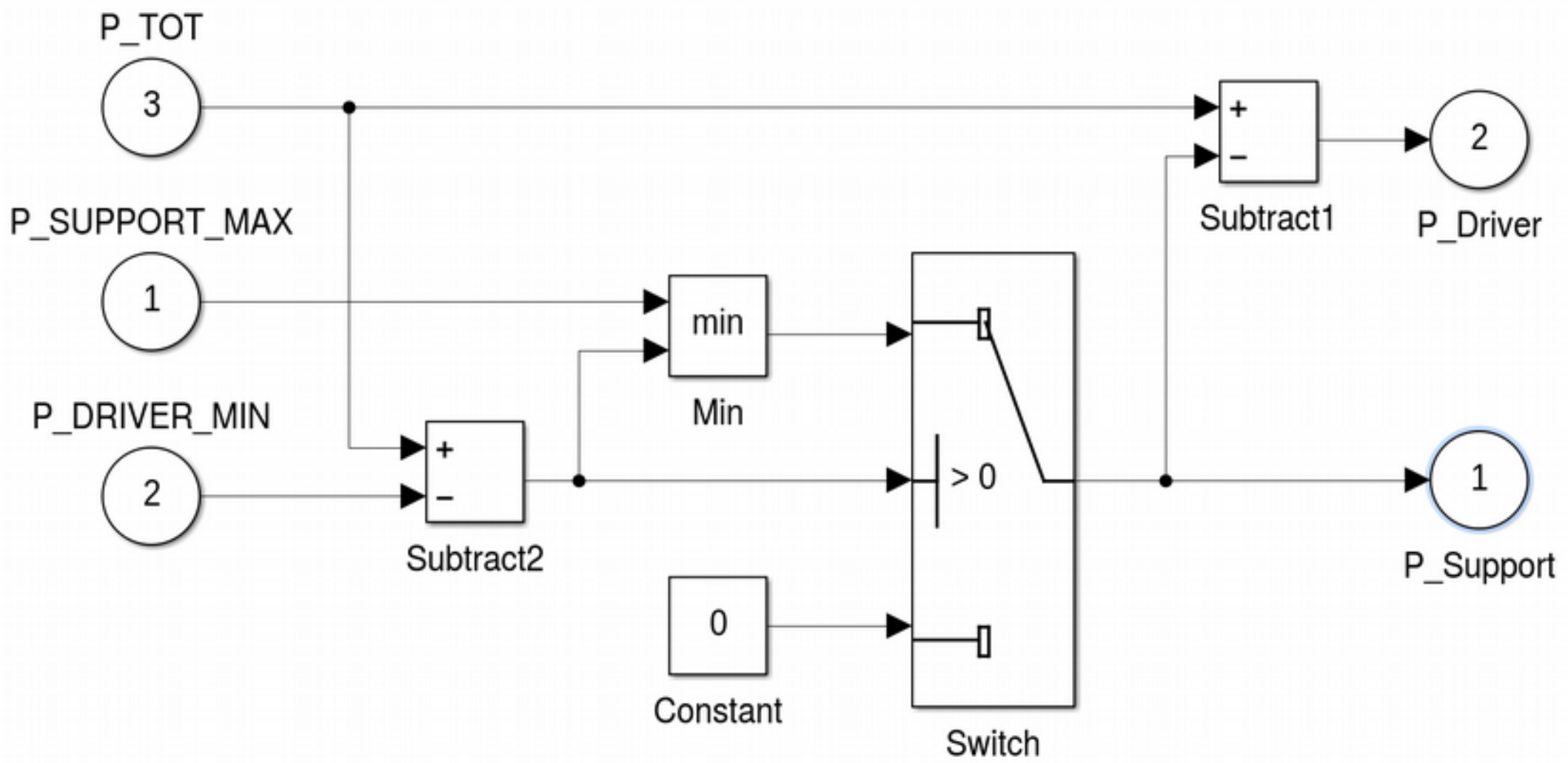
Power Support Subsystem



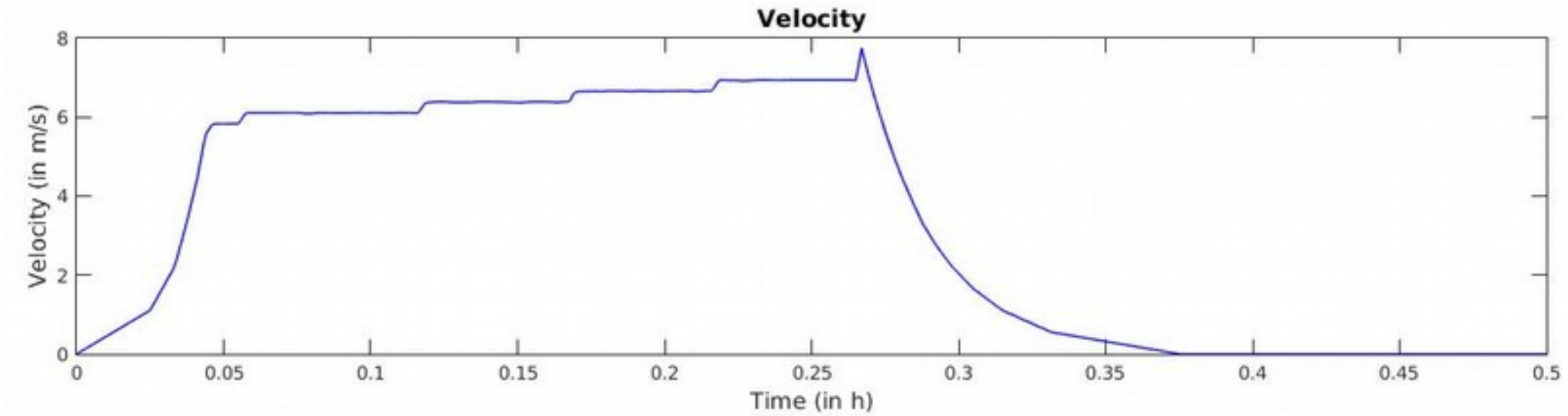
Power Support Based On Speed

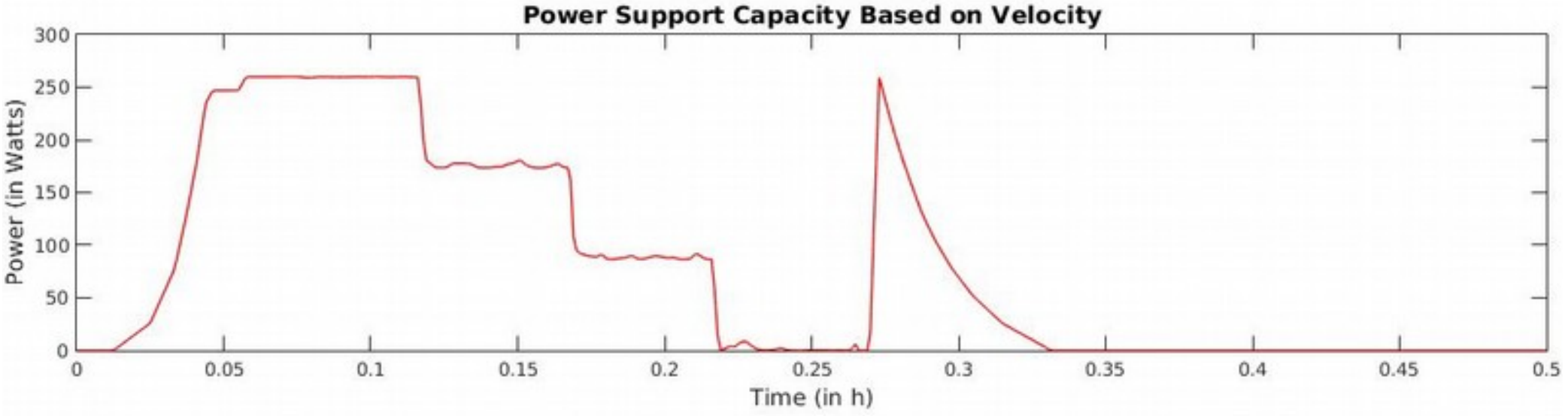


Power Distribution Between Driver and Motor

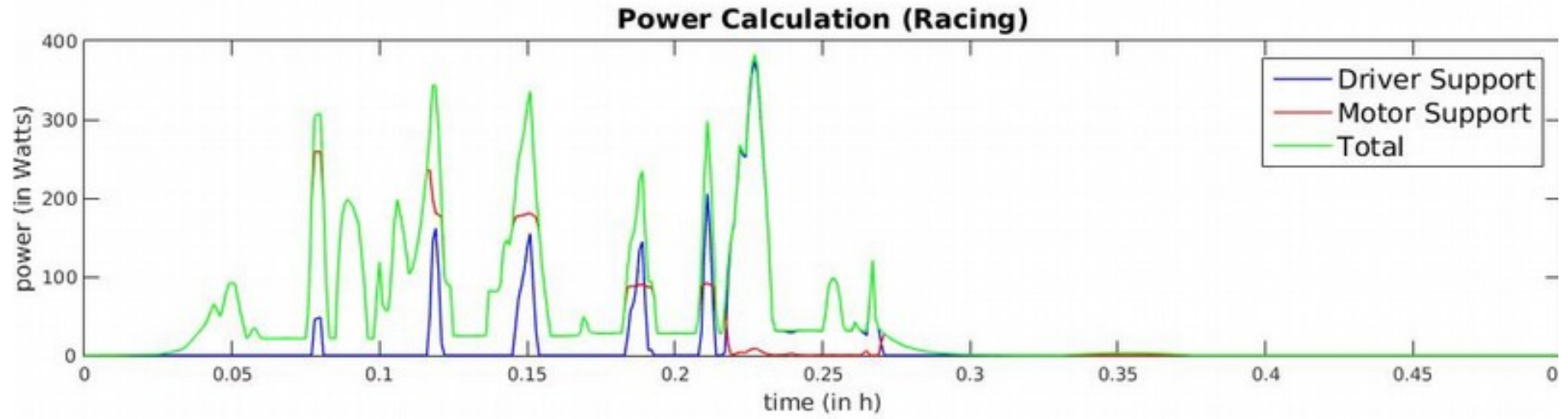


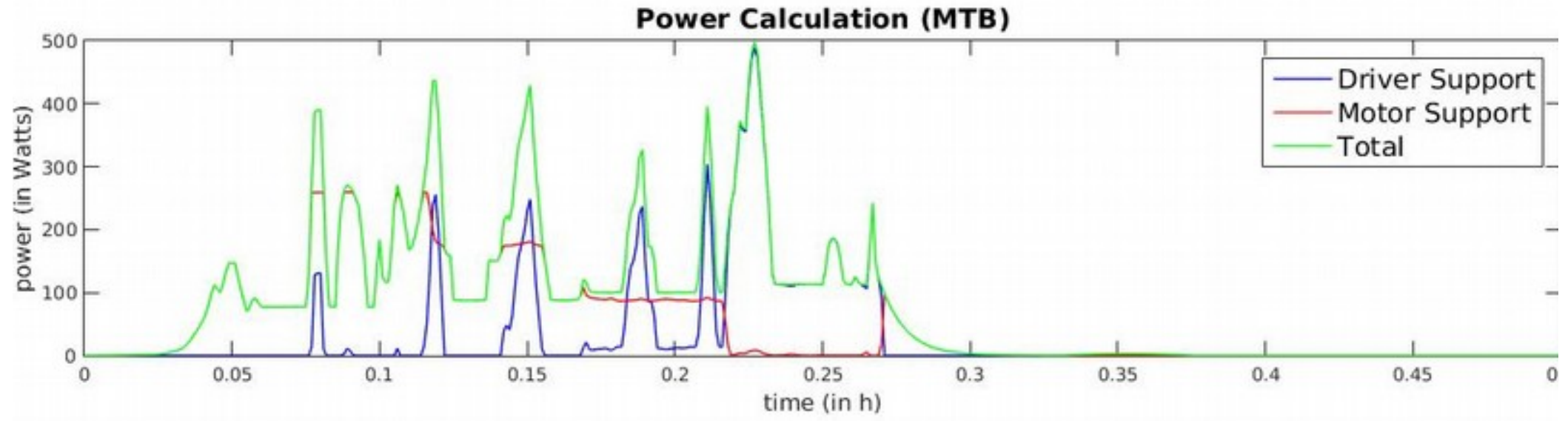
Maximum Power Support Capacity Based on Velocity





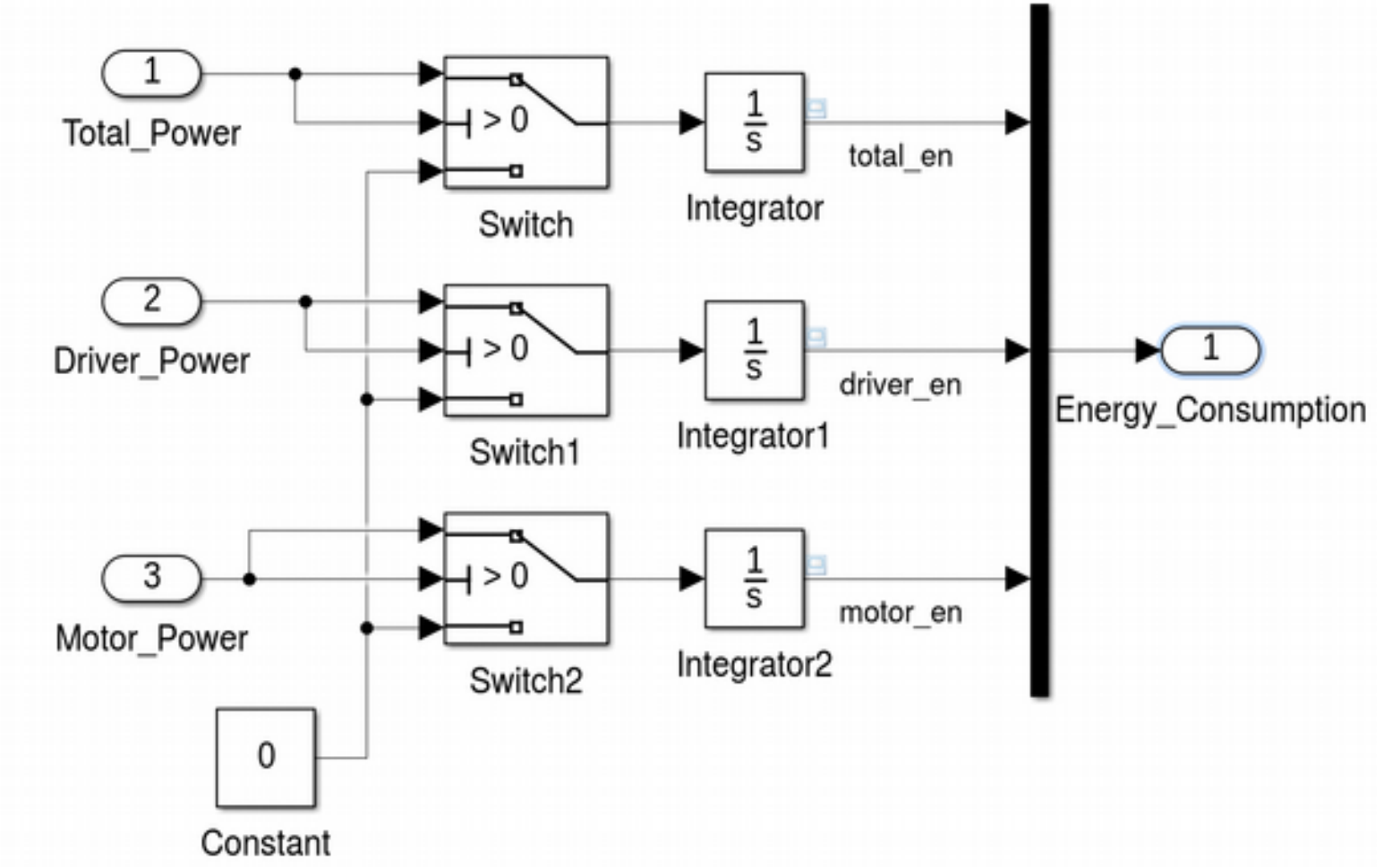
Power – MTB vs Racing Bike





Energy Consumption Subsystem

$$W_{Track} = \sum_{i=1}^{n_t-1} W(s_i) = \sum_{i=1}^{n_t-1} P(s_i) \cdot t_i.$$



Energy – MTB vs Racing Bike