FUEL, ENERGY EMISSION CALCULATION FOR MACHINERY SYSTEM (FEEMS)
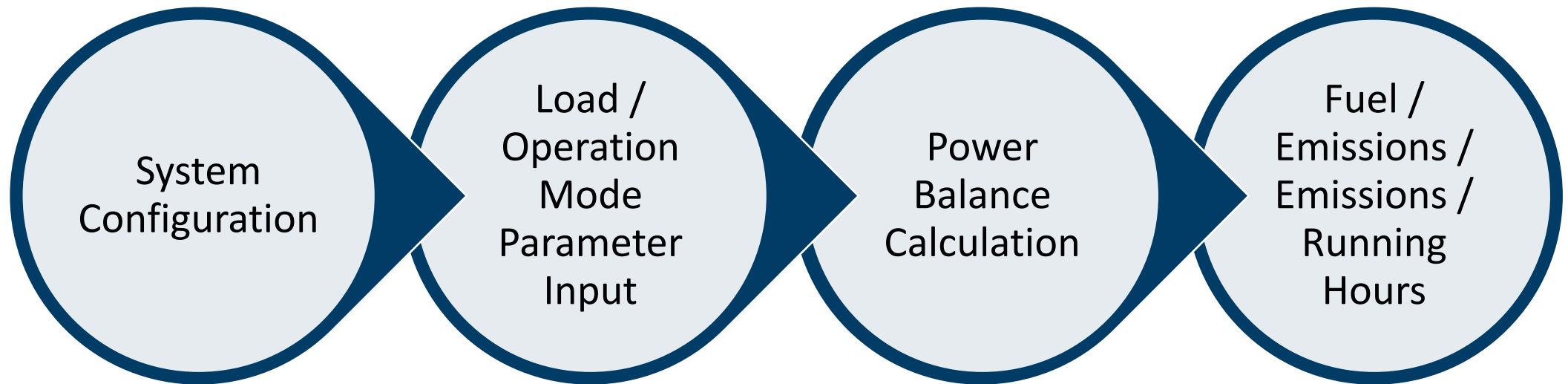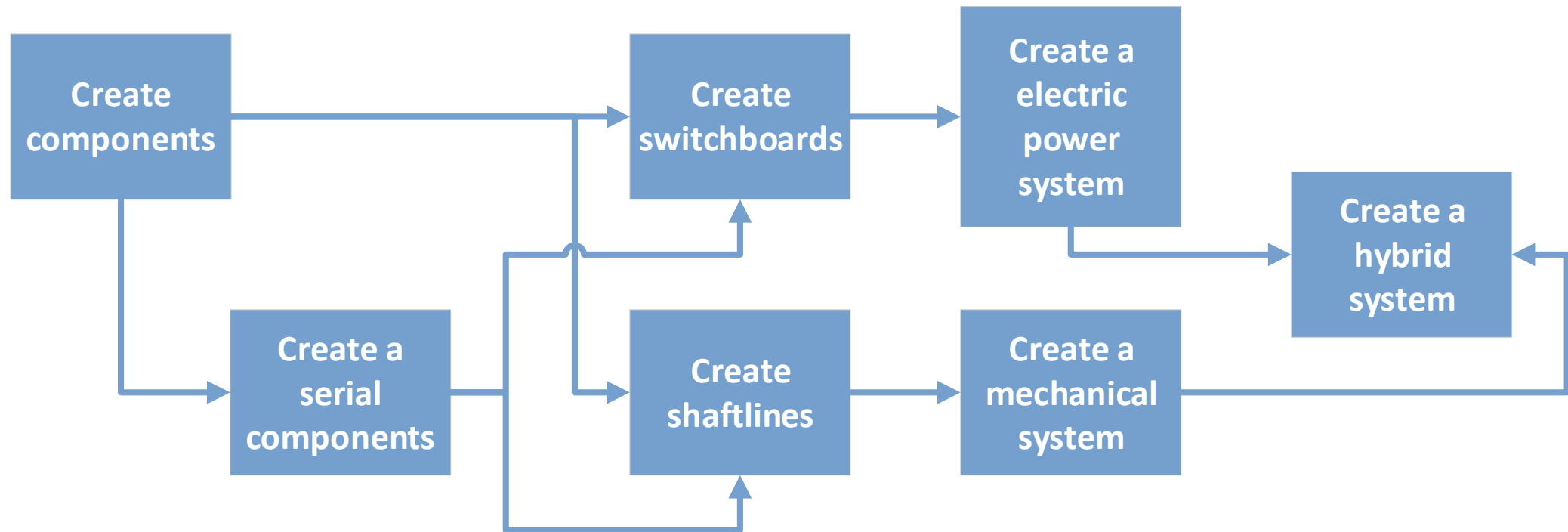
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Overview

- FEEMS is modeling framework for a marine power and propulsion system for calculation of fuel consumption, emissions, and energy balance with the input of operation mode and external power load.

- In this framework, a modeler can configure a power system based on the single line diagram and component library. It supports the following types of power / propulsion systems:
  - Hybrid/Conventional Diesel Electric Propulsion
  - Hybrid Propulsion with PTI/PTO
  - Mechanical Propulsion with a Separate Electric Power System

- After the system model is configured, given the operational control inputs and power load on the consumers, power balance calculation is performed to obtain the load on the power producers. Then fuel/emission calculation is performed.
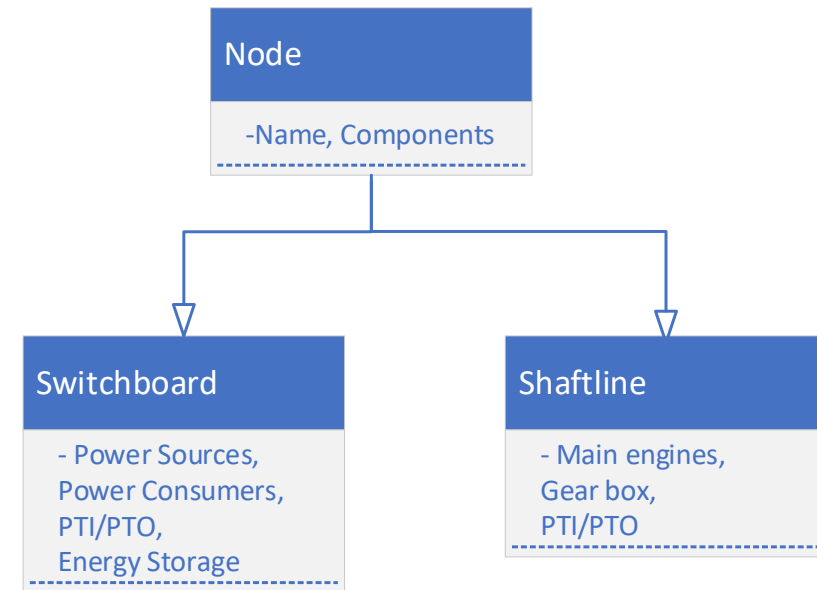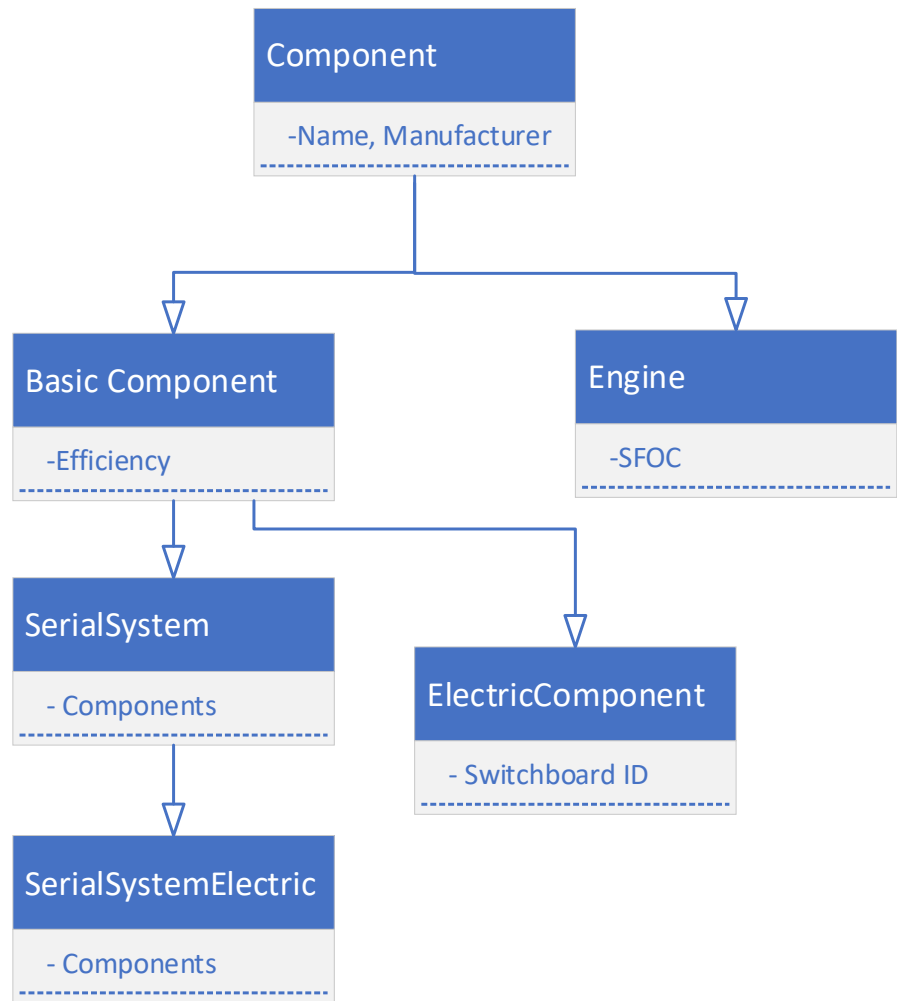
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Work Process

System Configuration → Load / Operation Mode Parameter Input → Power Balance Calculation → Fuel / Emissions / Emissions / Running Hours

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System Configuration

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Components

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┌─────────────────────────┐
│ Component               │
├─────────────────────────┤
│ -Name, Manufacturer     │
└─────────────────────────┘
```

Basic Component
- Efficiency

Engine
- SFOC

SerialSystem
- Components

ElectricComponent
- Switchboard ID

SerialSystemElectric
- Components

Node
- Name, Components

Switchboard
- Power Sources,
Power Consumers,
PTI/PTO,
Energy Storage

Shaftline
- Main engines,
Gear box,
PTI/PTO

Basic Principles

- Sign convention for basic component
  - Forward power $P_{in},\ P_{out} > 0$
    - $PL = \dfrac{P_{out}}{P_{rated}}$
    - $\eta = \dfrac{P_{out}}{P_{in}}$
  - Reverse power $P_{in}, P_{out} < 0$
    - $PL = \dfrac{P_{in}}{P_{rated}}$
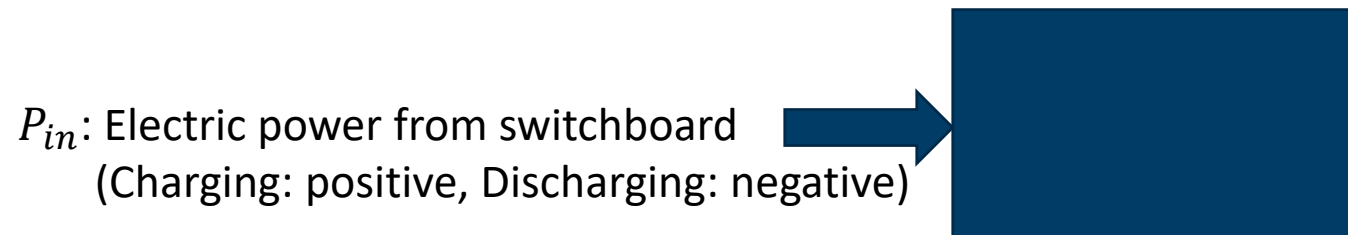   - $\eta = \dfrac{P_{in}}{P_{out}}$

P_{in} → [ ] → P_{out}

Specific for each power type

- Generator / Power sources

P_{in}: Mechanical / Fuel Power → [ ] → P_{out}: Power to the switchboard

- Power consumer / transmission

P_{in}: Electric power from switchboard
(Charging: positive, Discharging: negative) → [ ]

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Specific for each power type

- PTI/PTO

P_{in}: Electric power from switchboard
(Motoring: positive, Generating: negative)

P_{out}: Shaft power

- Energy Storage

P_{in}: Electric power from switchboard
(Charging: positive, Discharging: negative)

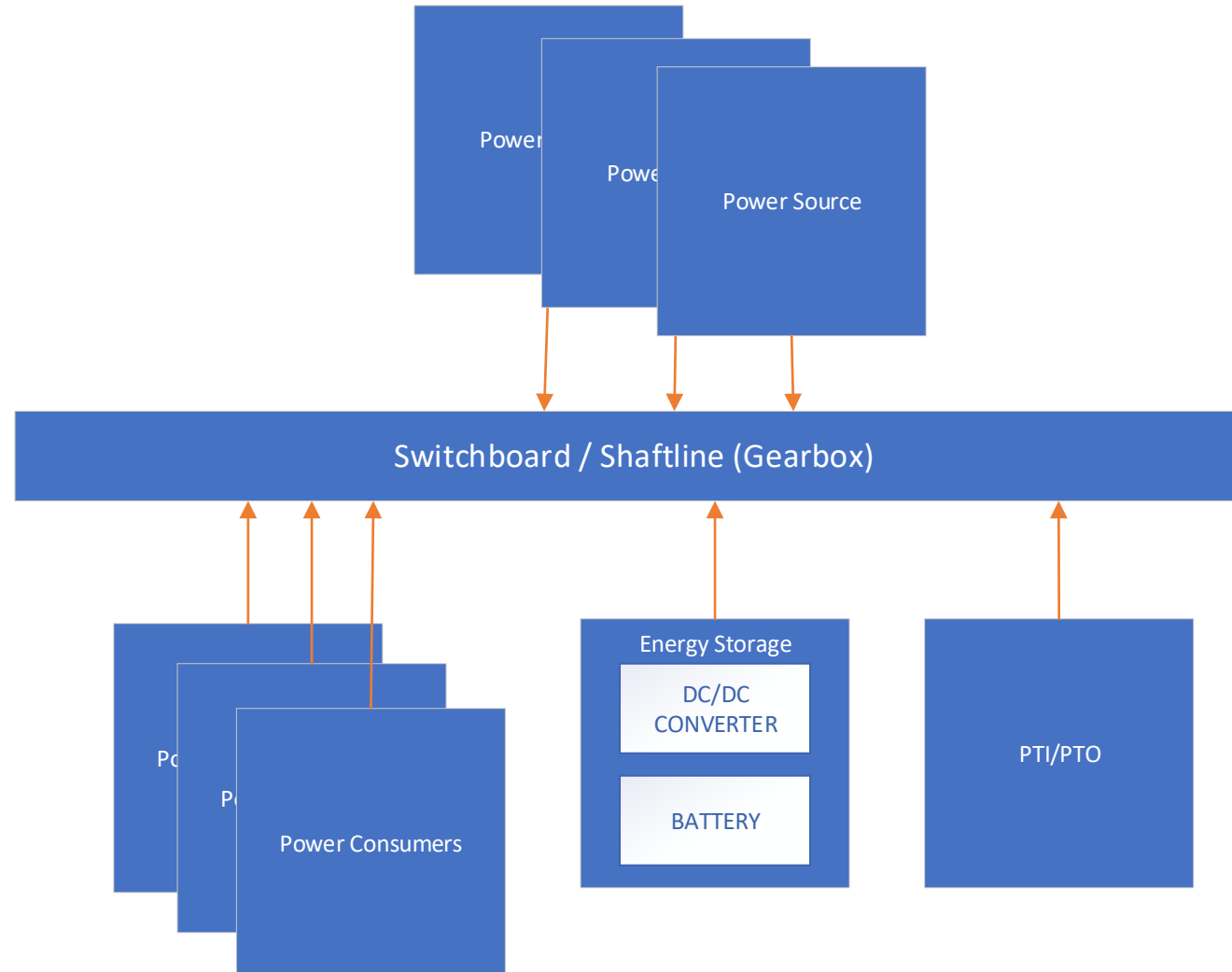SINTEF
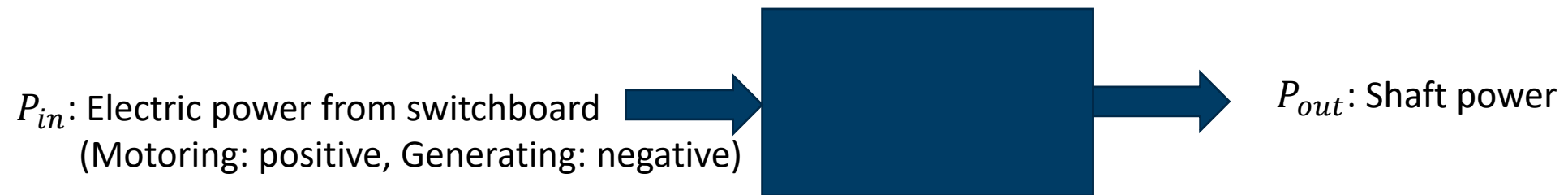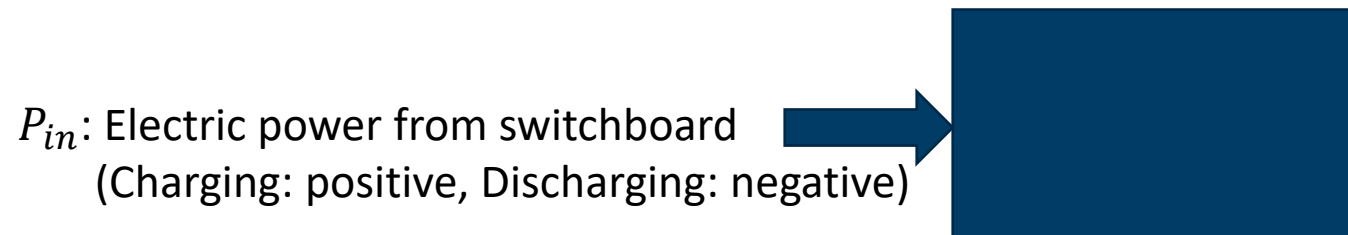
System Configuration

- Only one level depth is allowed for the node calculation

Power balance calculation

- Function: system_model.ElectricPowerSystem.do_power_balance_calculation ()

- Purpose: Find the power balance to find the power output of the gensets, PTI/PTO machine and/or ESS which are in a symmetric load sharing mode

- Steps
  - Set the power consumption at the loads by giving its output power. If the power consumption is known value at the switchboard side, then it is also possible to set the value directly by
  - Find the bus loads in kW which are symmetrically shared by the power producers:

$$P_{\mathrm{b,symm}_i} = \sum_{j=1}^{N_{\mathrm{swbd}}} c_{ji} \cdot P_{\mathrm{s,\,symm}_j}$$

  - Calculate the bus load %

$$\%P_{\mathrm{b,symm}_i} = \frac{P_{\mathrm{b,symm}_i}}{\sum_{j=1}^{N_{\mathrm{swbd}}} c_{ji} \cdot P_{\mathrm{s,avail,symm}_j}}$$

Power balance calculation
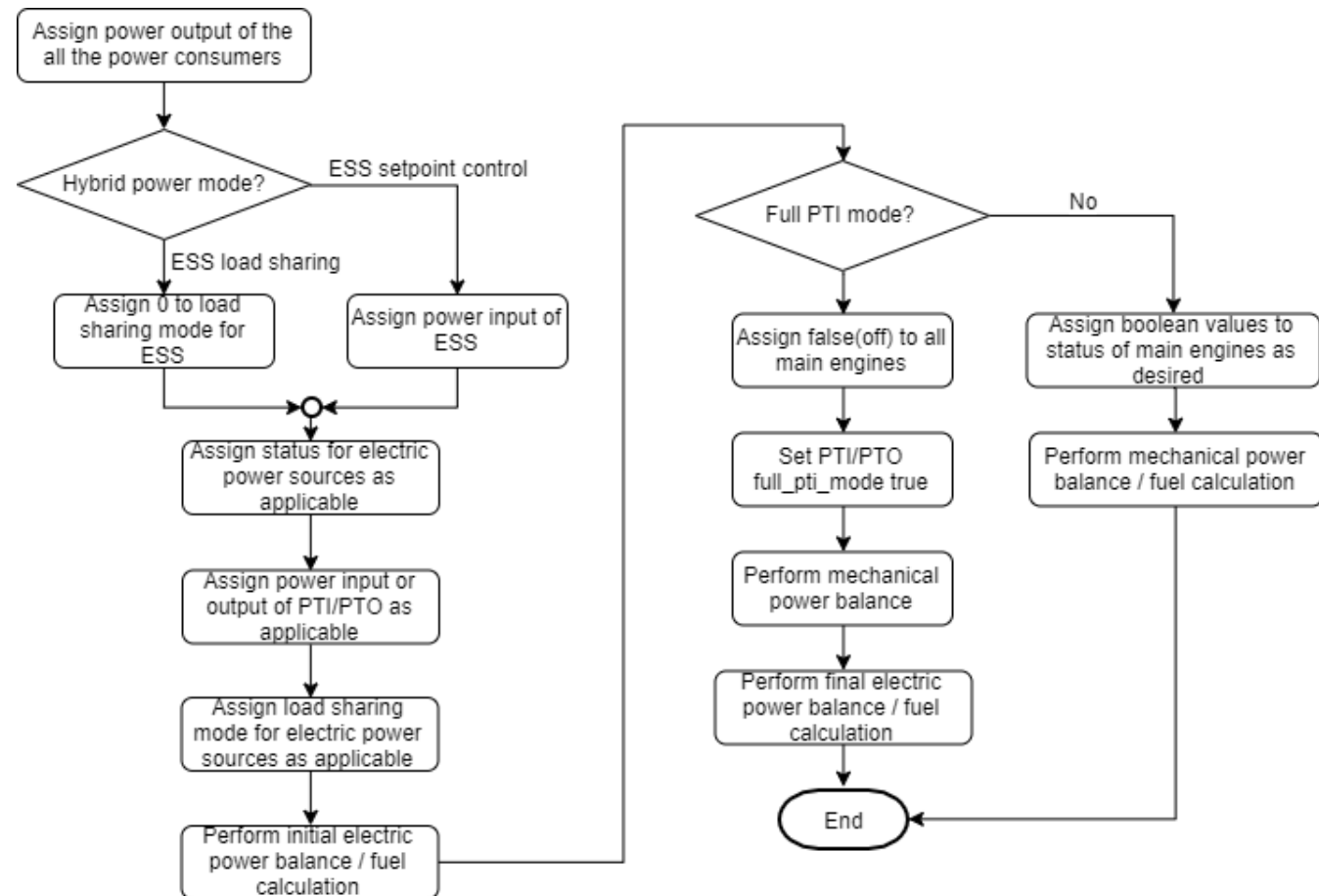
User story – Power System

- As a user, one should be able to set the values of the power load (output) of each components

Series components system as a single component

- Sign convention for basic component

  - Forward power $P_{in},\ P_{out} > 0$
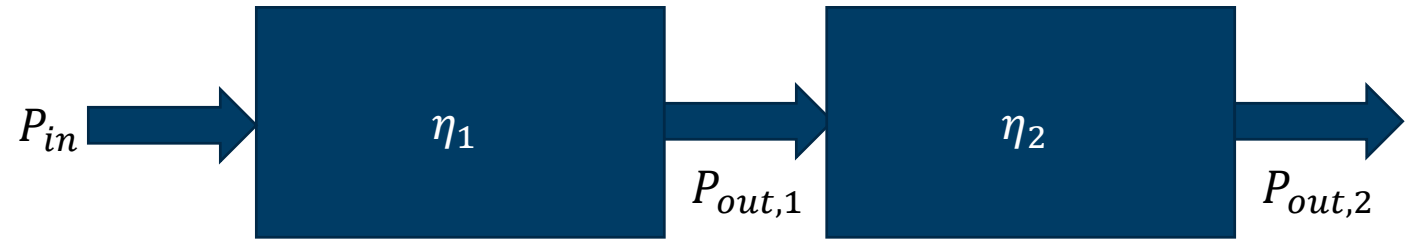
    - $PL = \dfrac{P_{out}}{P_{rated}}$

    - $\eta = \dfrac{P_{out}}{P_{in}}$

    - $P_{\text{out},2} = \eta_1 \eta_2 P_{\text{in}}$

  - Reverse power $P_{in}, P_{out} < 0$

    - $PL = \dfrac{P_{in}}{P_{rated}}$

    - $\eta = \dfrac{P_{in}}{P_{out}}$

P_{in} $\rightarrow$ η_1 $\rightarrow$ $P_{out,1}$ η_2 $\rightarrow$ $P_{out,2}$

70 år

1950-2020

Teknologi for et bedre samfunn