CONTROLS OPTIMIZATION FOR ENERGY EFFICIENT COOLING AND VENTILATION AT CERN

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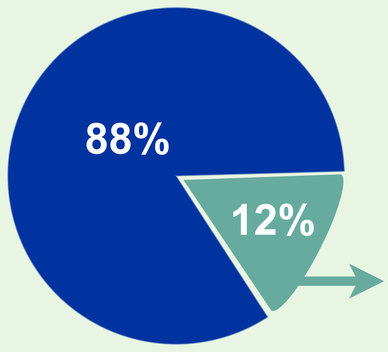
Air Conditioning - Water Cooling - Fluid Distribution

comes with a **high energy cost!**

Large Hadron Collider (LHC) Electricity Consumption



Cooling and Ventilation

75 GWh/year = 20 000 european households

Figure 1: Cooling and ventilation plants at CERN

CONTROLS OPTIMIZATION

-50%

Electricity Savings

- **Software-only** modifications
- **Tested on real plants** at CERN
- **Quick payback period**

Controls Optimization, a cost-effective strategy for energy savings in industrial plants!

Controls Optimization Method

systematic and **safe** platform to test new control algorithms

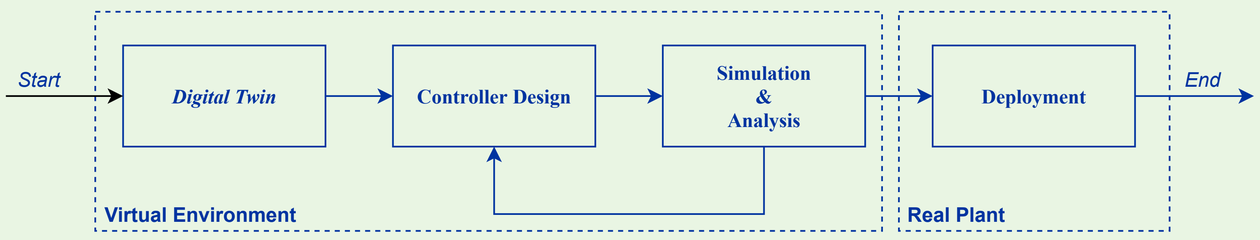


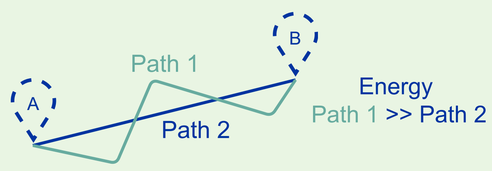
Figure 2: Workflow of controls optimization method

Digital Twin

- Digital plaform replicating the dynamics of the plant;
- Built using pure physical relations, manufacturer specifications, and/or data-driven models (e.g. model-fitting with historical data);
- Verify real world behaviour of plant under arbitrary conditions;
- Use of flow and heat transfer simulation software and libraries, such as Flownex®;

Controller Design

- Controller is the system's driver!



- From classical PID controllers to advanced formulations, such as Model Predictive Control (MPC);

Simulation & Analysis

- Test and performance assessment of controller designs;
- Controller selection based on:
  1) performance of set-point tracking;
  2) minimization of energy consumption;

Deployment

- Solution implemention on PLC-based industrial control system;
- Several items are prepared on this phase: specification, PLC code development, testing, and training of operators;

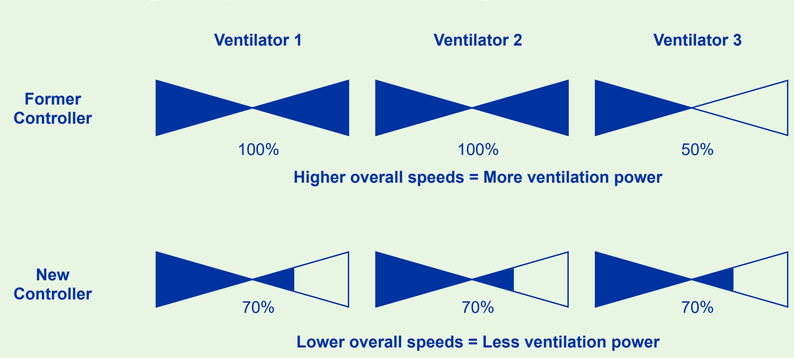
LHC Cooling Towers

Project Example

Six cooling tower plants (10 to 50 MW) for heat extraction of the LHC.

Optimized controller for energy savings, developed and tested following the Controls Optimization Method. Deployed since 2020.

- **New staging strategy** for ventilators
- **Reduced average speed** of running ventilators



Investment Figures

Investment: 1 FTE Control Engineer (1 year)

Return: -400 k€/year during LHC run[1]

Payback Period: <1 year

Messages to take home...

Energy savings and **reuse** is a priority for CERN, including for cooling and ventilation systems

Controls Optimization is cost-effective
Do better with existing equipment!

Strategy validated on industrial plants and savings backed by **real results**

What's next ?
- **Controls optimization** on more plant types using advanced methods (e.g. MPC);
- **Active monitoring** of energy-efficient parameterization of systems;
- Low-tech/High Potential: **demand-based controls;**

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[1]Based on average non-household EU electricity prices in 2021 (145 €/MWh)