

Application case 2 : Fuzzy logic applied to energy management

Reflection and analysis exercise

You are given 3 slides taken from a power point presentation done by a PhD student from HEI L2EP in ELECTRIMACS conference (Spain 2014). Well understand the problematic and the objectives then respond to the question.

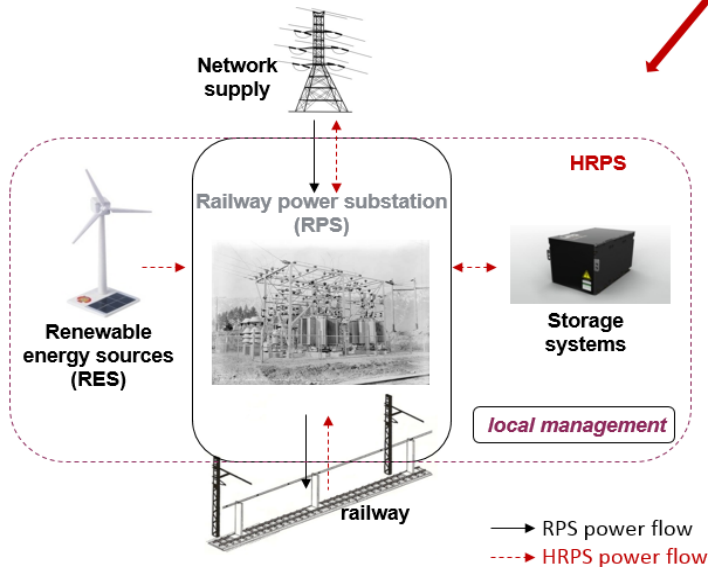
INTRODUCTION

3

Context

- 90% railway traffic ensured by electrified lines (French railway network: 1500VDC & 25kV/50Hz AC)
- railway traffic increasing
- electricity market liberalization

New solutions to face future energy demand increase
(Hybrid Railway Power Substation)



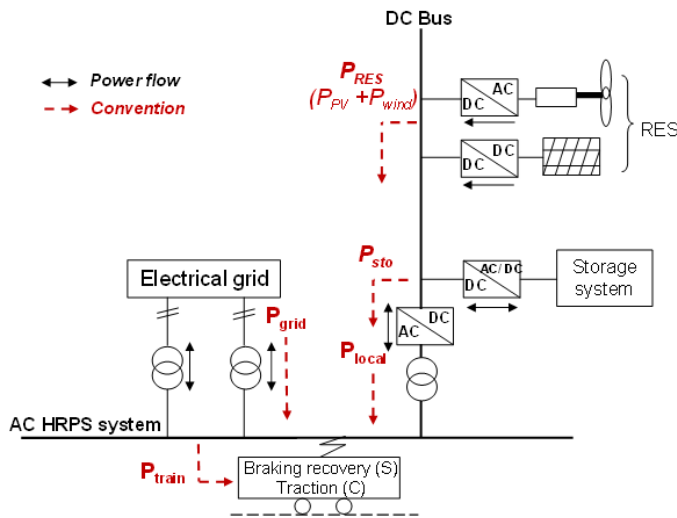
Economic issue:

- HRPS energy bill reduction
- Optimizing the energy purchasing strategy

In energy terms:

- Power flow identification in HRPS system
- Energy management objectives definition in order to satisfy energy and economic constraints

Hybrid Railway Power Substation architecture



Hybrid system composed of:

- photovoltaic (PV) units
- wind turbines
- storage systems
- DC-bus interconnection to the power substation (allowing isolation mode if necessary)

➤ Power flow balance:

RPS: → $P_{train} = P_{grid}$ ($P_{local} = 0$)

HRPS: → $P_{train} = P_{grid} + P_{local}$

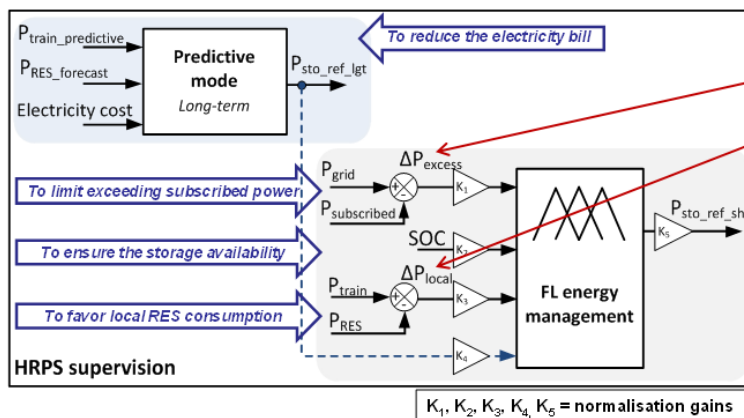
→ $P_{local} = P_{RES} + P_{sto}$

- P_{train} is the railway power consumption seen by the HRPS
- P_{grid} is the power taken from the grid
- P_{local} is the local production (PV, wind, thus P_{RES})
- P_{sto} is the storage power



Methodology for HRPS energy management

STEP 2
Design of the supervisor



the grid power excess amount

the power difference between train consumption and RES production

$K_1, K_2, K_3, K_4, K_5 =$ normalisation gains



Question: Complete this table for work specifications (problem analysis):

STEP 1
Work specifications

| Objectives | Constraints | Means of actions |
|---|-------------|------------------|
| <i>Predictive mode – LONG TERM</i> | | |
| | | |
| | | |
| | | |
| <i>Fuzzy Logic energy management – SHORT TERM</i> | | |
| | | |
| | | |
| | | |

Correction

Reflection and analysis exercise

STEP 1
Work specifications

| Objectives | Constraints | Means of actions |
|--|---|---|
| <i>Predictive mode – LONG TERM</i> | | |
| Reducing energy bill (regarding short-term trades) | Trains consumption predictions RES forecast Electricity market fluctuations | Storage power ($P_{sto-ref-lgt}$) (Predictive reference power) |
| <i>Fuzzy Logic energy management – SHORT TERM</i> | | |
| Limitation of subscribed power exceeding Favoring local RES consumption Ensuring storage system availability | Subscribed power Storage limits RES availability | Storage power ($P_{sto-ref-shrt}$) (Predictive mode adjustment) |