2nd International Conference on Smart Energy Systems and 4th Generation District Heating
"Aalborg, 27-28 September 2016

Modelling the effect of the transmitted information quality on the management of 4th Generation district heating

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4DH
4th Generation District Heating
Technologies and Systems

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Nantes

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CONTENTS

1. CONTEXT
2. METHODOLOGY
3. CASE STUDY
4. RESULTS AND DISCUSSION
5. CONCLUSION & FUTURE WORK

CONTEXT

ENERGY EFFICIENCY POLICIES

→ **Challenge for District Heating**

4TH GENERATION DISTRICT HEATING :

- RES integration
- Storage integration
- Low temperature
- **SMART**

} Sustainability & Competitiveness

→ NEEDS OF INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT) :

- Which technology is the most adapted ?
- What impact on the DH control?

CONTEXT

WIRELESS ICT FOR SMART DH :

- Can be a cheap solution
- Can adapted for existing and new DH

BUT

- Limited transmission time and capacity
- Limited data transmission due to encoding needs
- Non negligible information losses

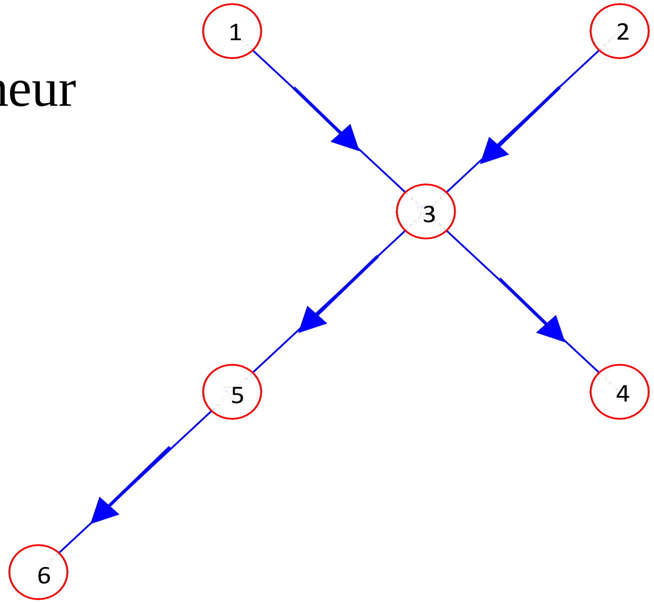
→ Need of modelling DH functioning with limited information on demand

METHODOLOGY

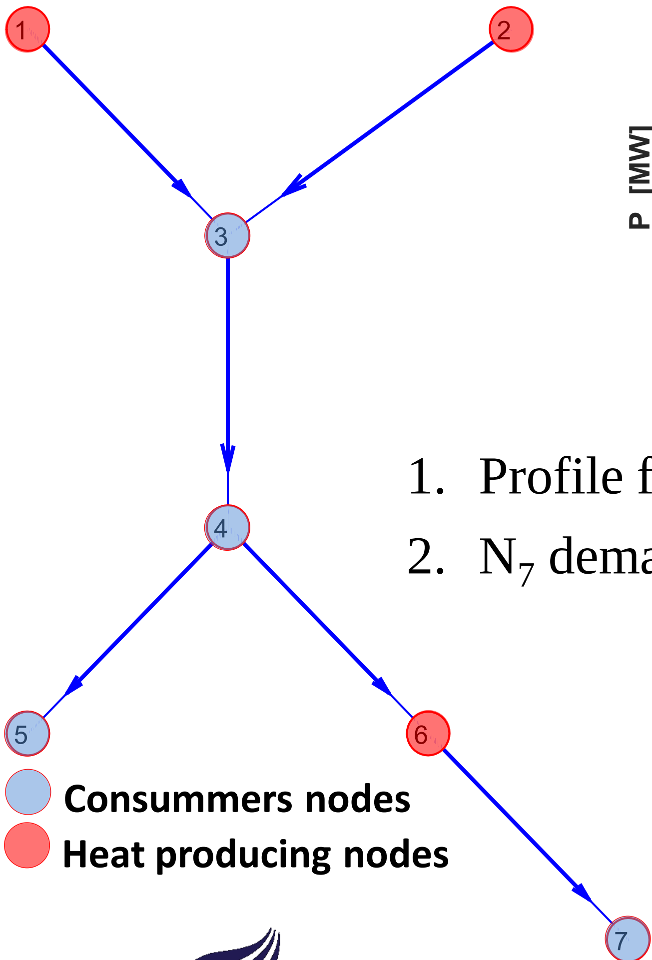
HEATGRID : DH MODELLING AND OPTIMIZATION TOOL

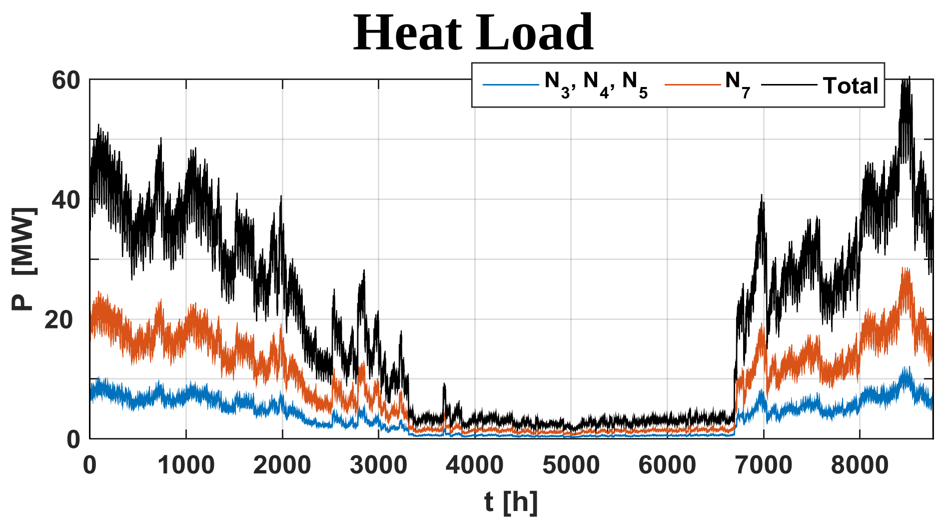
- Multiple thermal sources models
- Optimization function : linear programming
- Oriented graph formalism
- Input : load demand **(IDEAL OR TRANSMITTED)**

Nodes: consumer/source/prosumeur
Edges : distribution



Case Study



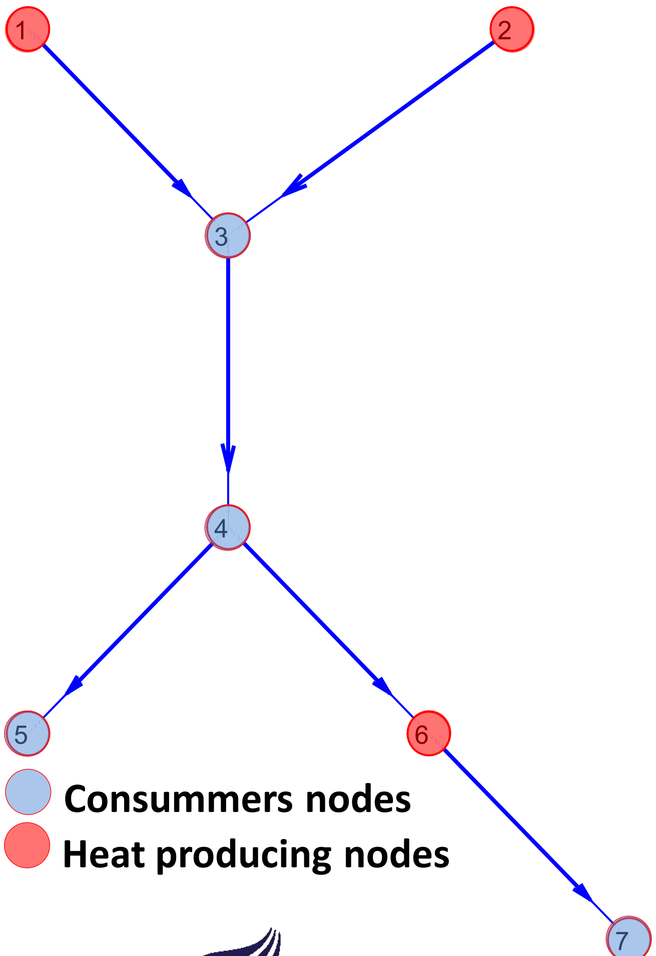


1. Profile from noised HDD decomposition of monthly consumption
2. N_7 demand 2.5 times higher than N_3, N_4 and N_5

Production

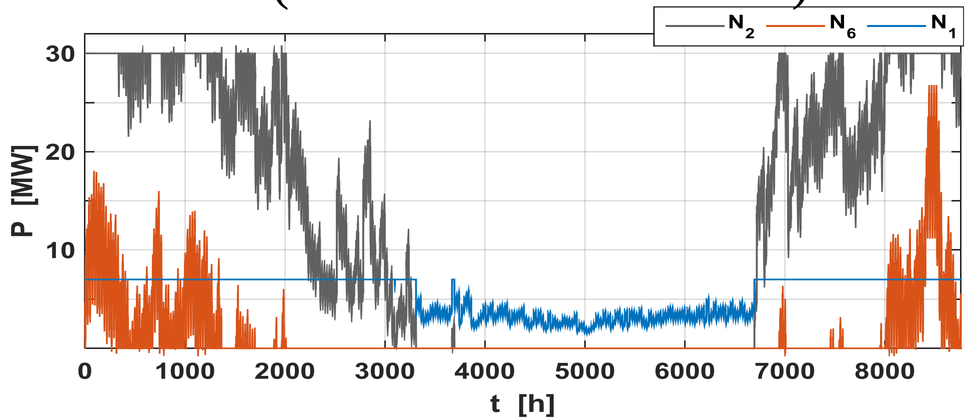
Node	Energy sources	Installed capacity[MW]	Cost [€/kWh]
1	Biomass	7	0.01
2	Gaz boiler	30	0.04
6	Gaz boiler	27	0.05

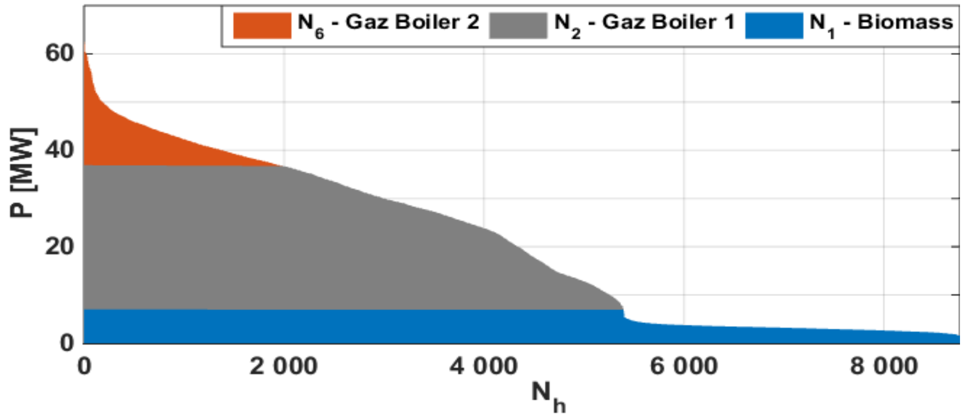
CASE STUDY



Consummers nodes
Heat producing nodes

Optimal heat supply scenarii
(Minute wise simulation)





Merit order respected :

1. N_1 supply the base load (all the year)
2. N_2 head backup and N_6 local backup

CASE STUDY

LoRa (Long Range radio)

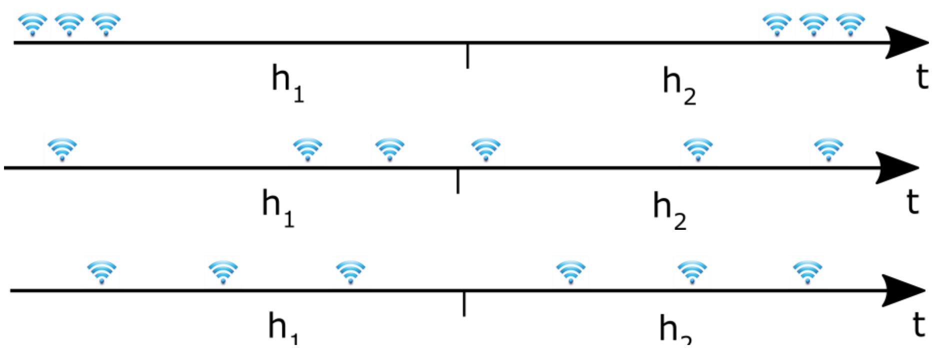
- 36 s/hour max
- 2 s for 50 bytes messages ⟶ 18 messages/hour
- Possible information losses : ~13 messages/hour ⟶ ~5 messages/hour

⟶ 3 sets of 3 measured variables $(\dot{m}, T_s, T_r)$ /message

⟶ 15 powers values/hour

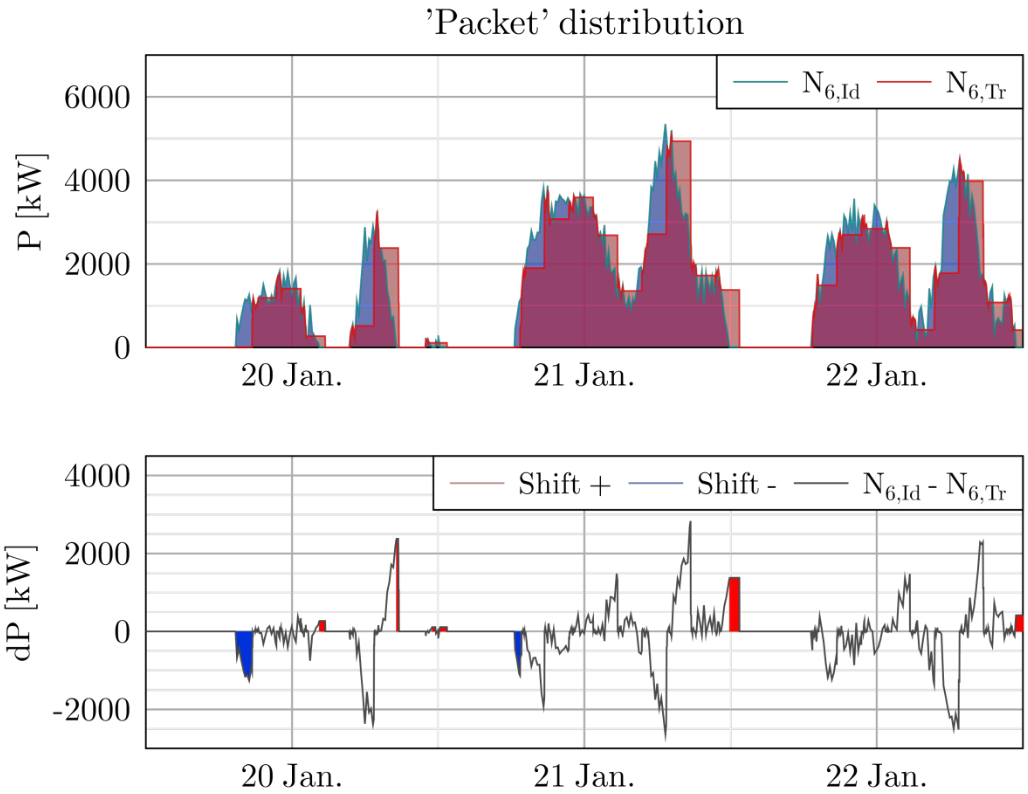
3 distributions of received messages :

1. ‘Packet’ distribution
2. Random distribution
3. Regular distribution



Results and Discussion

Shift of N_6 use : delays in turning on/off of the local backup N_6 compared to the ideal case.



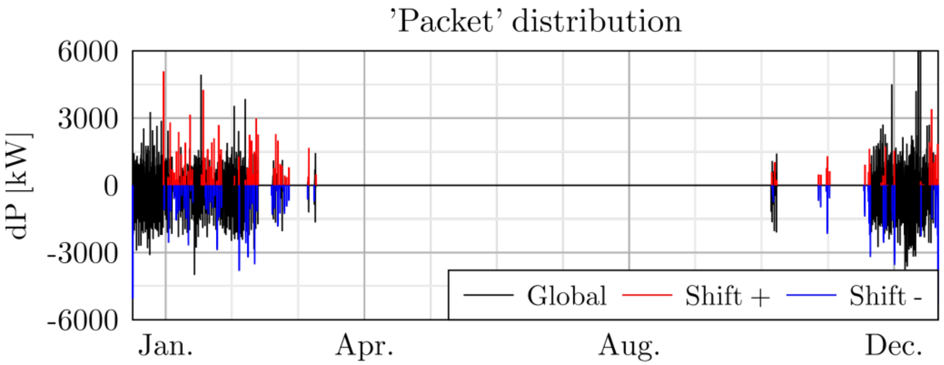
RESULTS AND DISCUSSION

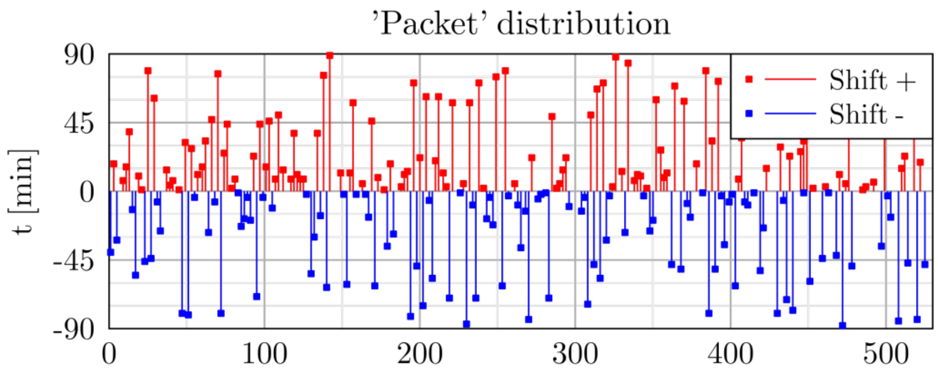
'PACKET' DISTRIBUTION

Maximal power differences **~ 6 MW**

Shift intervals durations:

Shift cumulated time	Mean duration	Max duration
7066' (6.10 %)	31'5''	90'





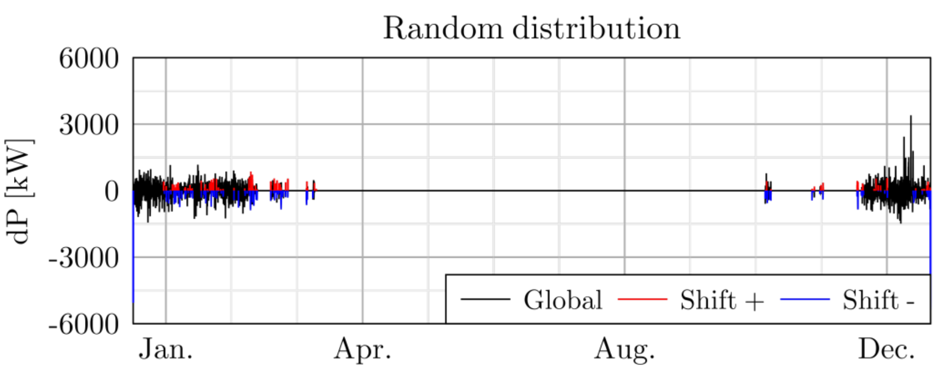
RESULTS AND DISCUSSION

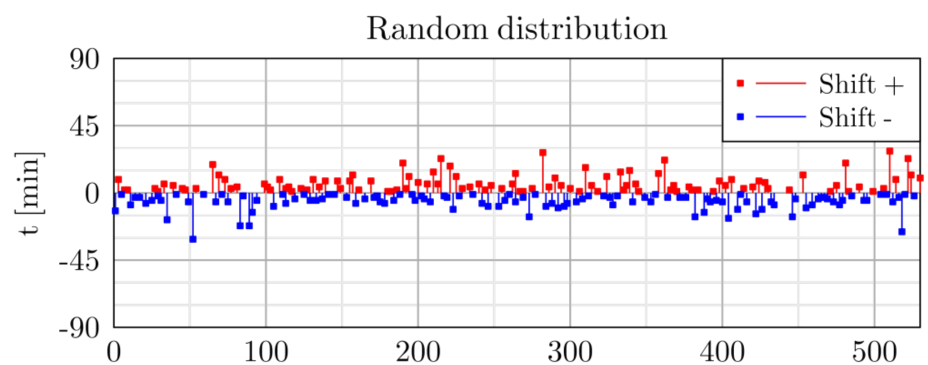
RANDOM AND REGULAR DISTRIBUTION

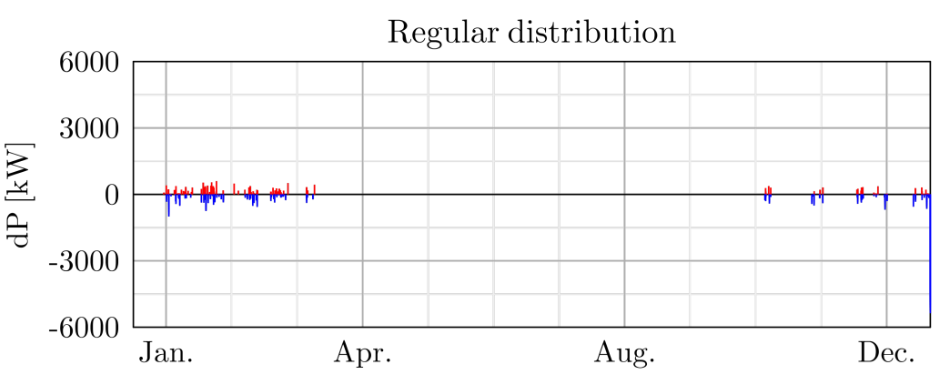
Maximal power differences **~ 1 MW**

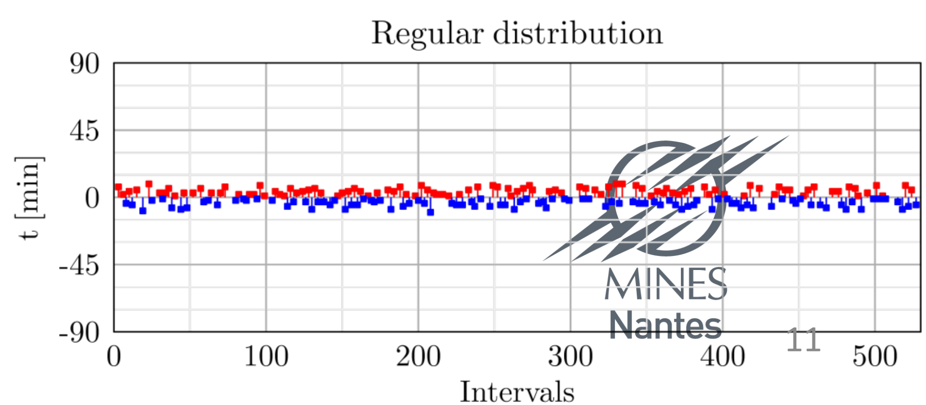
Shift intervals exists and last a few minutes :

Distribution	**Shift cumulated time**	**Mean duration**	**Max duration**
Random	1205’ (1.03 %)	4’20’’	31’
Regular	2105’ (1.80 %)	6’25’’	10’









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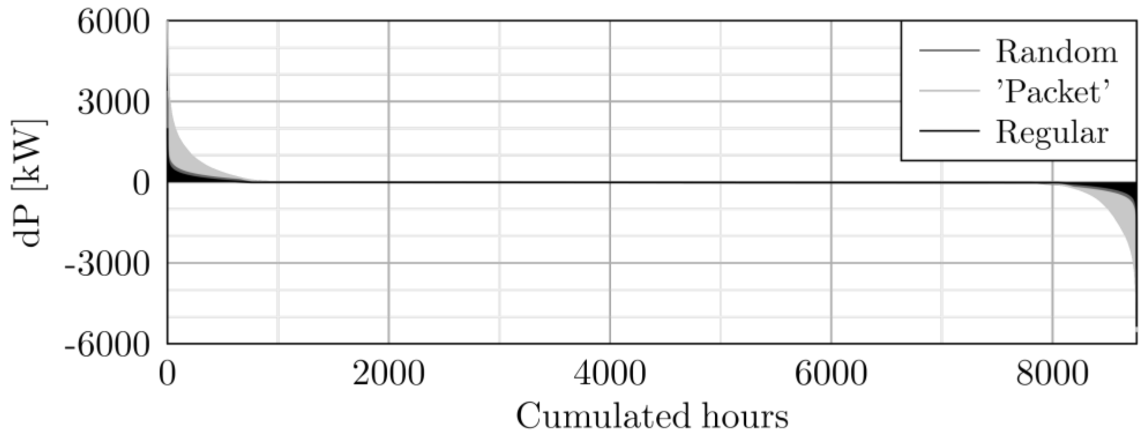
RESULTS AND DISCUSSION



Symmetrical monotones : Over and under-productions are quite similar

→ **Annual energy** over and under-productions comparable

Distribution	Over-production of local backup unit (N_6) [MWh]	Energy under-production of local backup unit (N_6) [MWh]
'Packet'	**642.2 (5.19 % of AP)**	**659.2 (5.33 % of AP)**
Random	215.1 (1.74 %)	215.7 (1.74 %)
Regular	133.0 (1.07 %)	134.0 (1.08 %)

CONCLUSION & FUTURE WORK

WIRELESS ICT ARE INTERESTING FOR SMART DH

WHATEVER THE TRANSMITTED MESSAGE DISTRIBUTION :

→ LOW IMPACT OF ENERGY SYSTEMS MANAGEMENT CONNECTED TO DH

1. Regular or random distribution : $\Delta P \sim 1$ MW – shift intervals ~ 5 mn
2. 'Packet' disttribution : $\Delta P \sim 6$ MW – shift intervals ~ 30 mn

NOW, LET'S SEE THE CONSEQUENCES CONSIDERING THE HEAT TRANSPORTATION TIMES AND INERTIA OF THE DH!

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Thank you

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