Saver
Self-Adaptive Energy Saver

François Gatto
Francois.Gatto@irit.fr

Marie-Pierre Gleizes
Marie-pierre.Gleizes@irit.fr

Lucas Elicegui
Lucas.Elicegui@bnextenergy.com

Summary

1. Some figures about energy
2. Adaptive Multi-agent System Theory
3. Saver architecture
4. Application example and results
5. Conclusion

SOME FIGURES

+30%

for 2020

Electricity price

8 Power plants

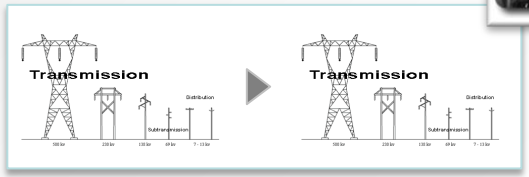
7000 MW

Required importations in case of cold winter or heat waves

Peak only

15 to 20%

Portion of the production capacity used only during peaks



ENERGY EFFICIENCY

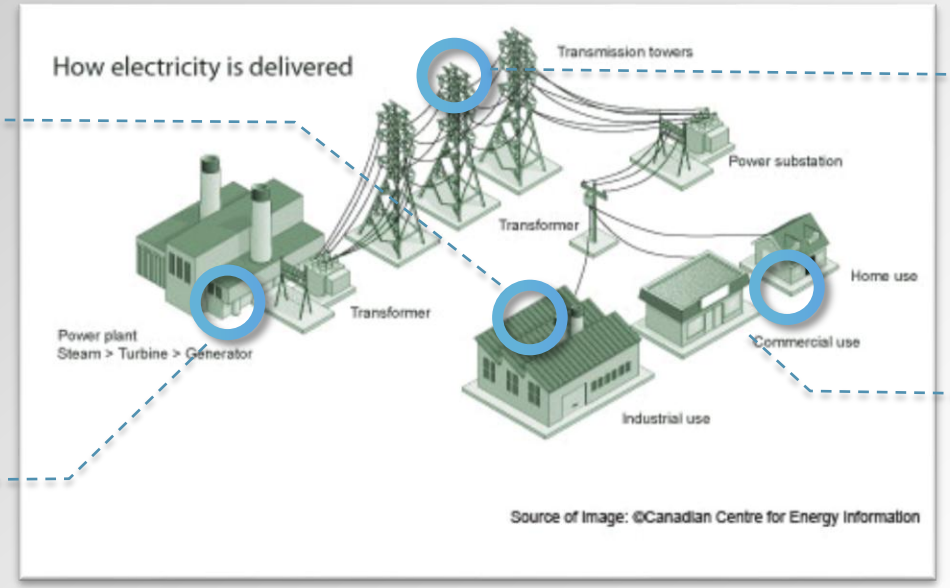
- **Bring smartness from production to consumption.**
  - Individual economy
  - Global management of the production and consumption variations.

Today

Consumption needs

Dictate …

Production and level needs



Tomorrow

Production capacities

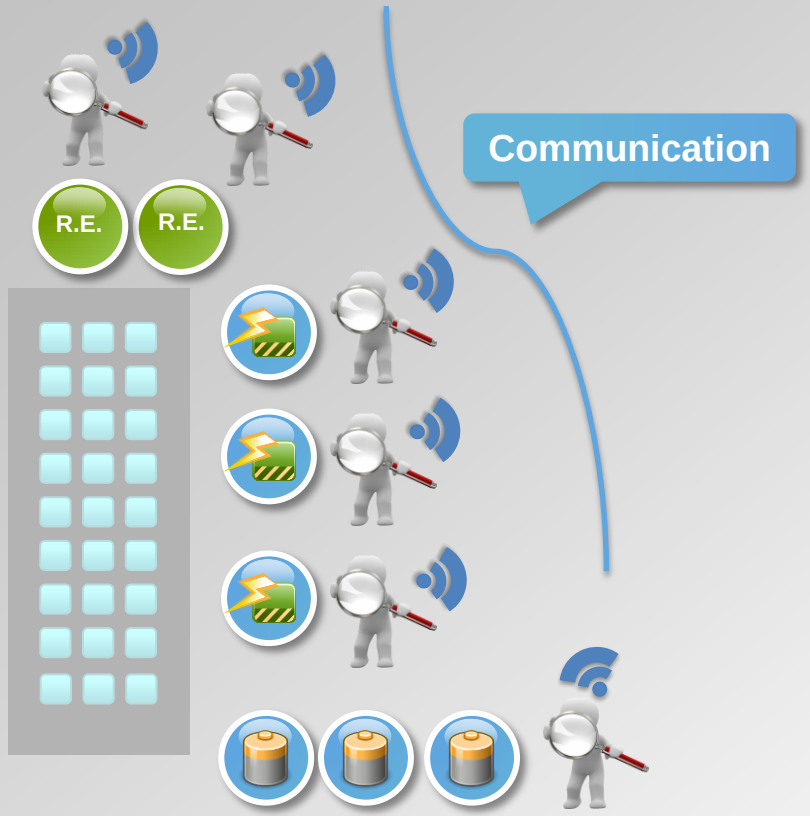
Align with …

Consumption needs

What is efficient energy management ?

- **Managing is controlling devices in an efficient way.**
- **Controlling efficiently :**
  - Keep giving them the appropriate set points over the time.

If a perfect system exists …

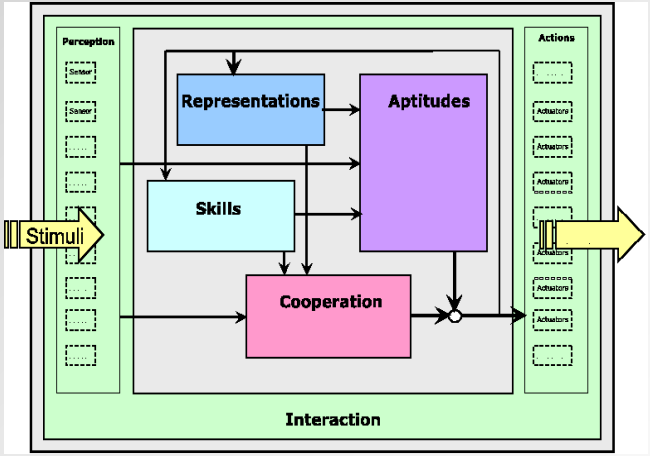


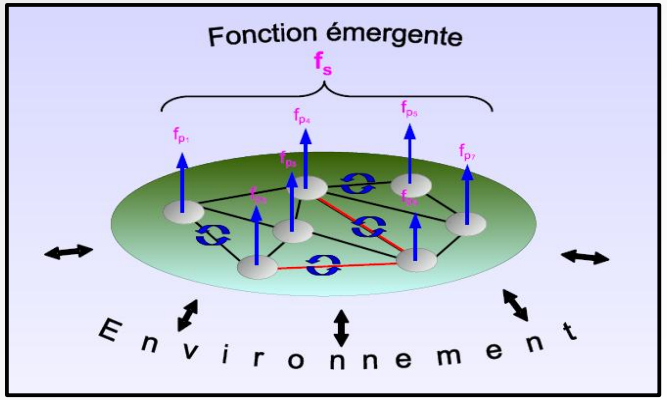
- Multi-agent system : system composed by *autonomous* and *independent* entities.
- Each agent adapts itself to the situation it perceives.
- The whole system behavior can be stated as *emergent*.

A weak individual intelligence FOR A great collective intelligence

Theoretical Approach

- **Agent**
  - Autonomous entity
- **Multi-agent system**
  - Group of interacting agents
- **Cooperation**
  - Perception : all perceived signals must be understood without ambiguity
  - Decision : received information is useful for the agent's reasoning
  - Action : reasoning leads to useful actions towards others
- **Cooperation as the engine for Self-organisation**.

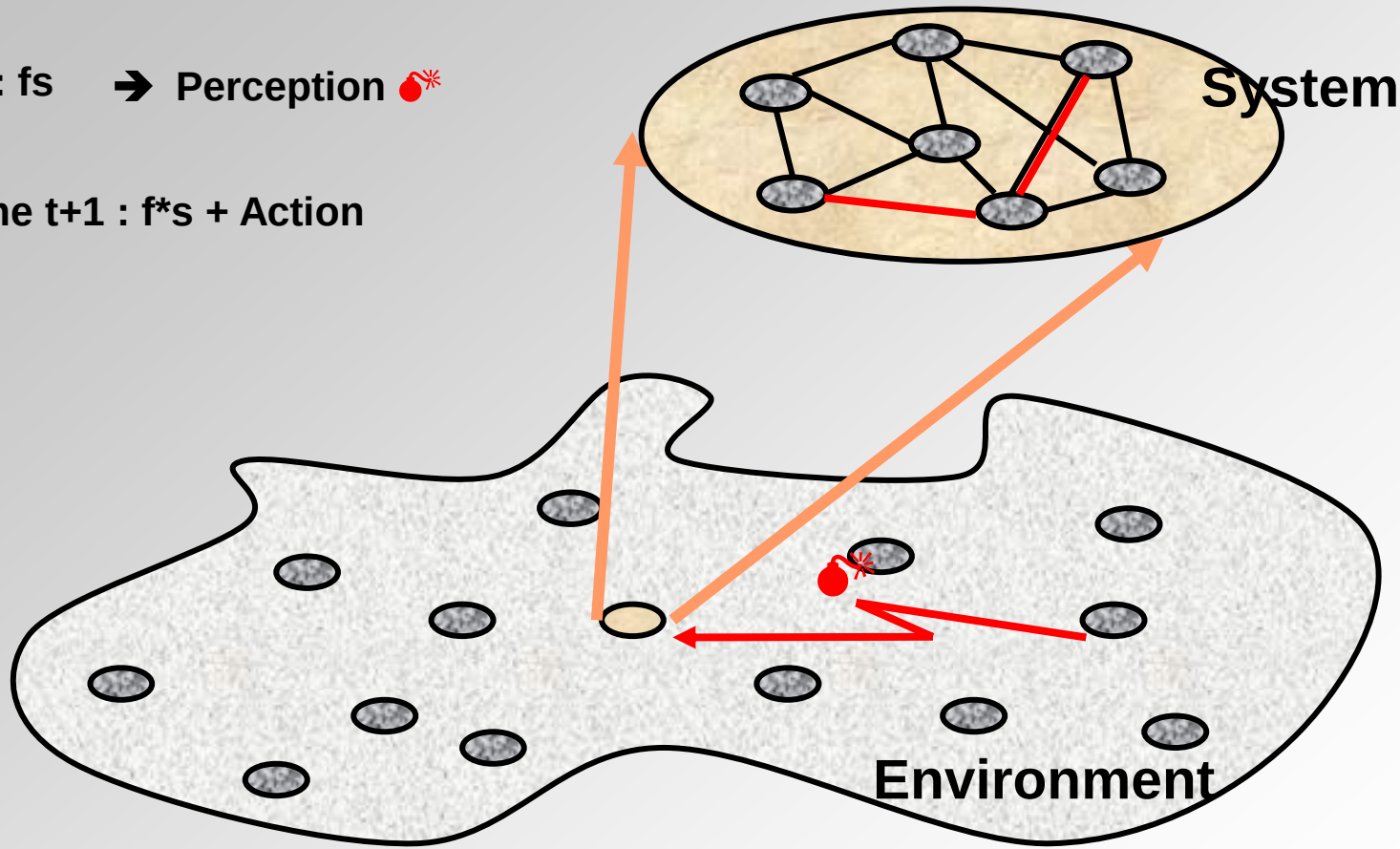




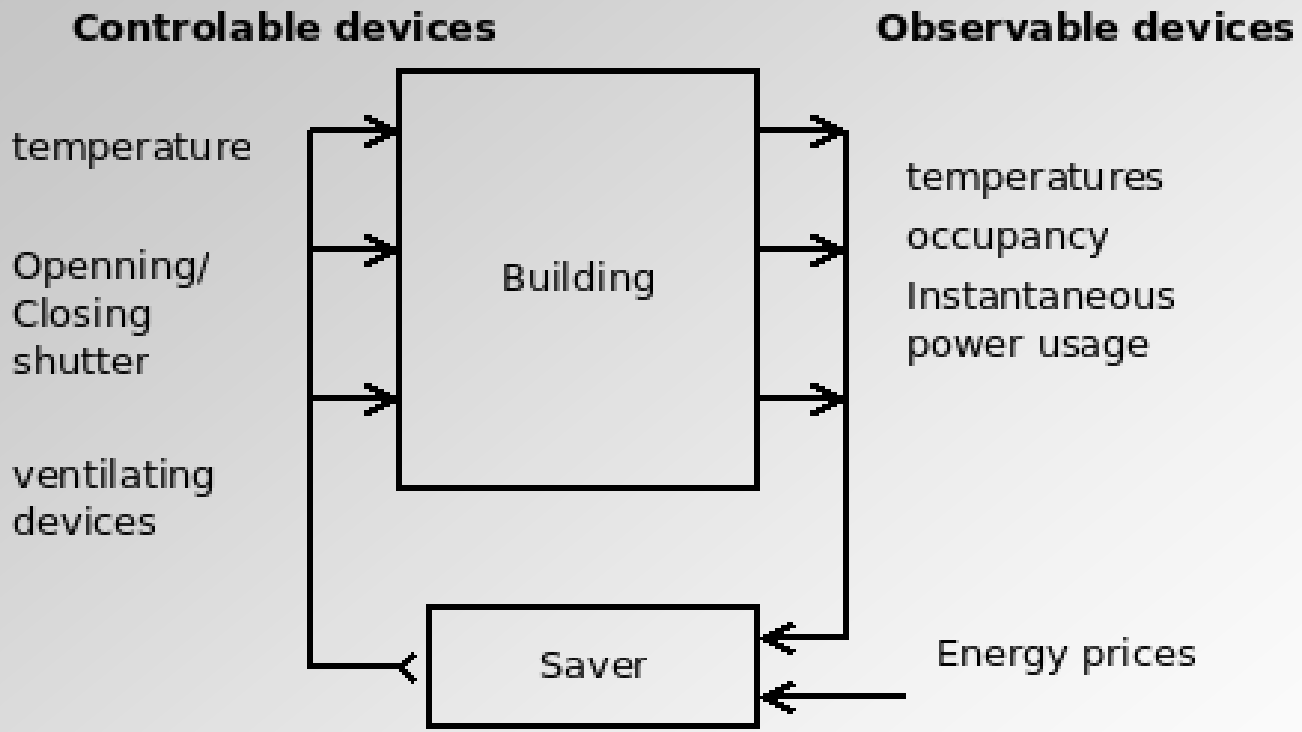
Principle of Self-Organisation in AMAS

Time t : fs ➔ Perception

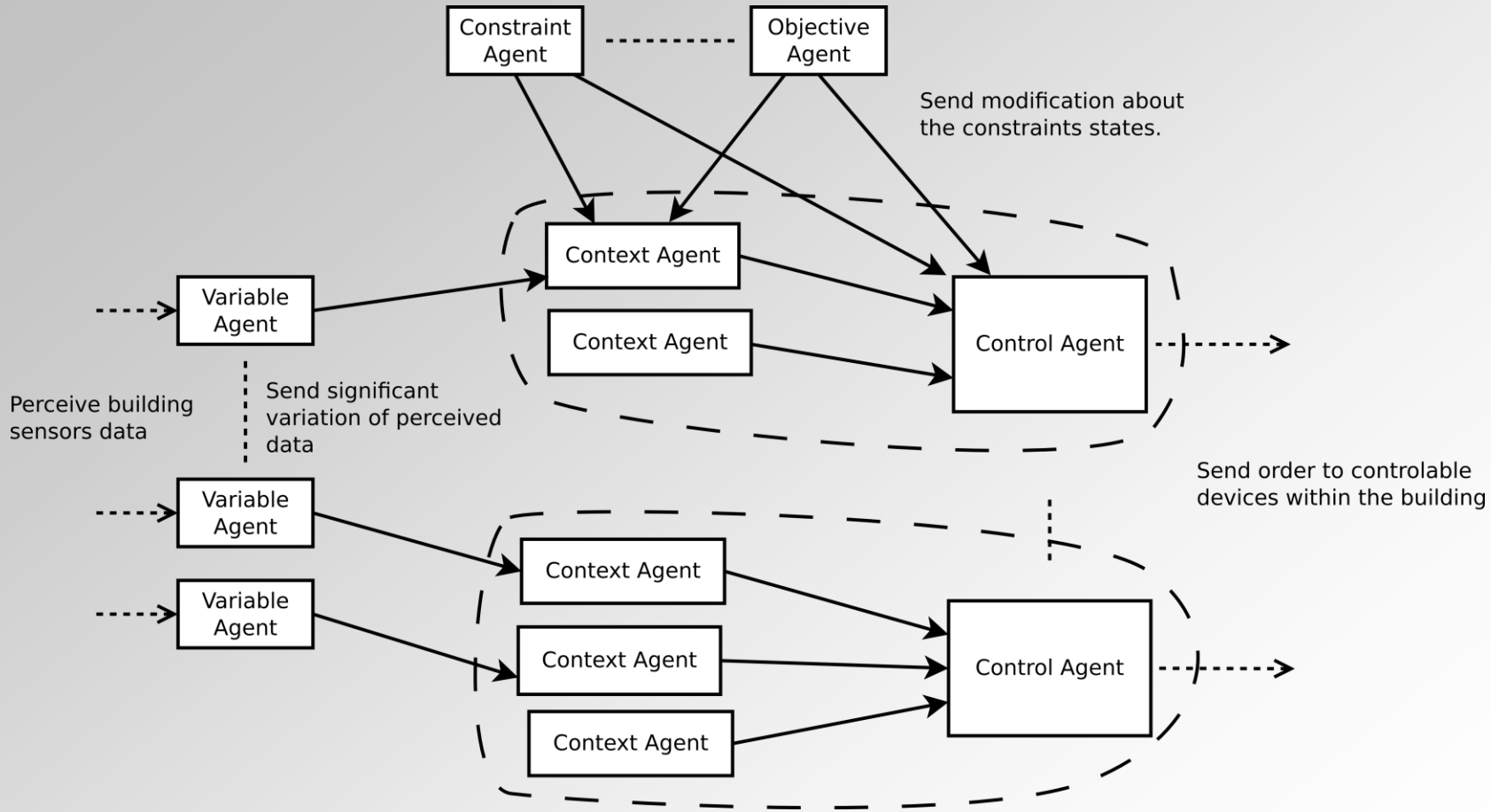
➔ Time t+1 : f*s + Action



Plugin Saver to Building

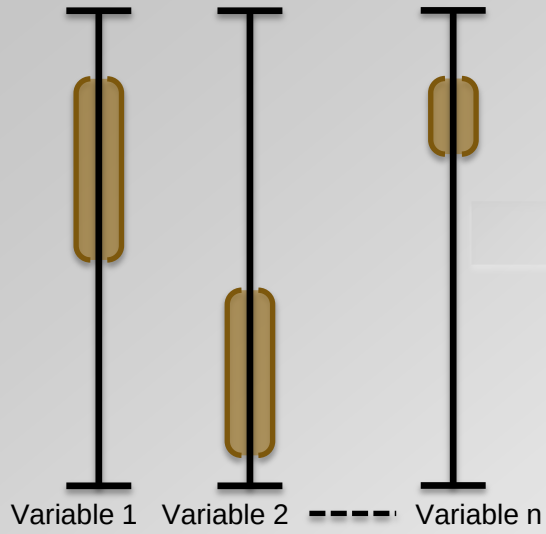


SAVER ARCHITECTURE



Context Agent

*"If the building is in **this state** and you apply **this action**, then **this will happen**"*

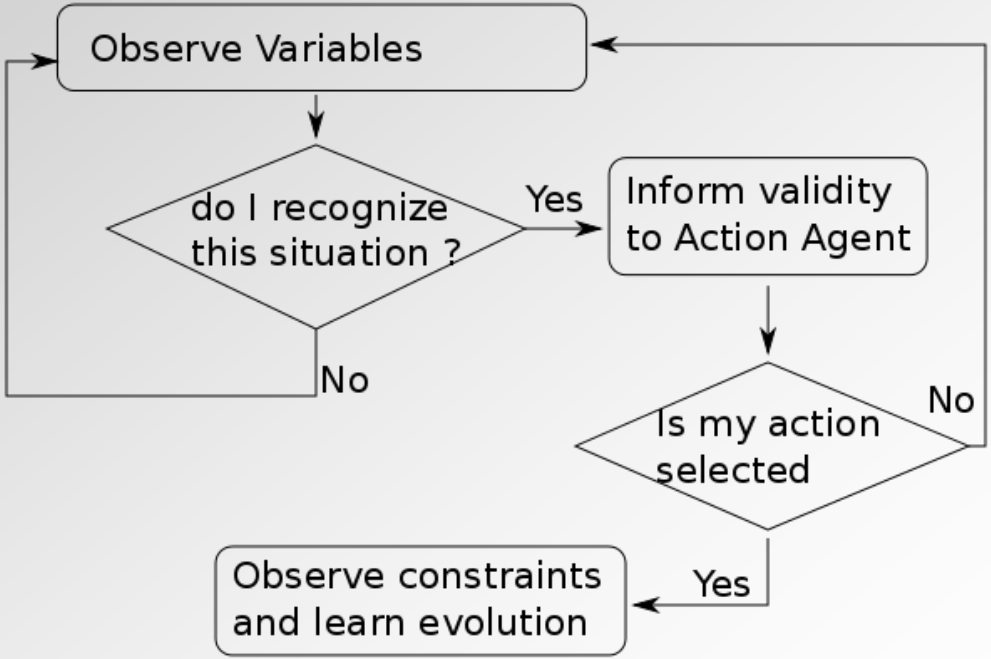


Set point
20° C

	Satisfaction Forecast
Constraint 1	+10
Constraint 2	-25
…	…
Objective 1	+12
…	…

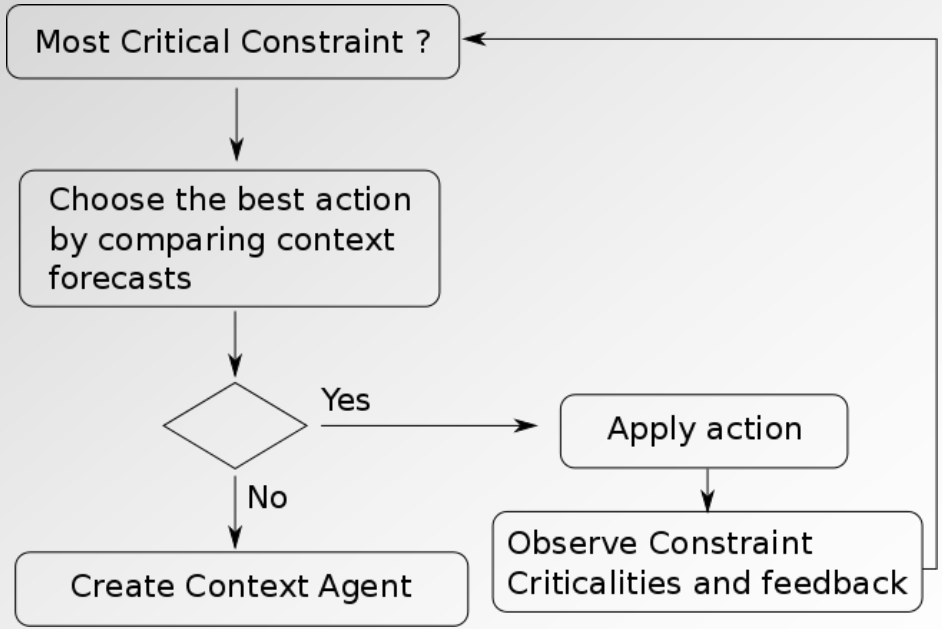
Context Agents

- **Propose an action to apply in the current state of the building**
- **Learn the consequences of its action**

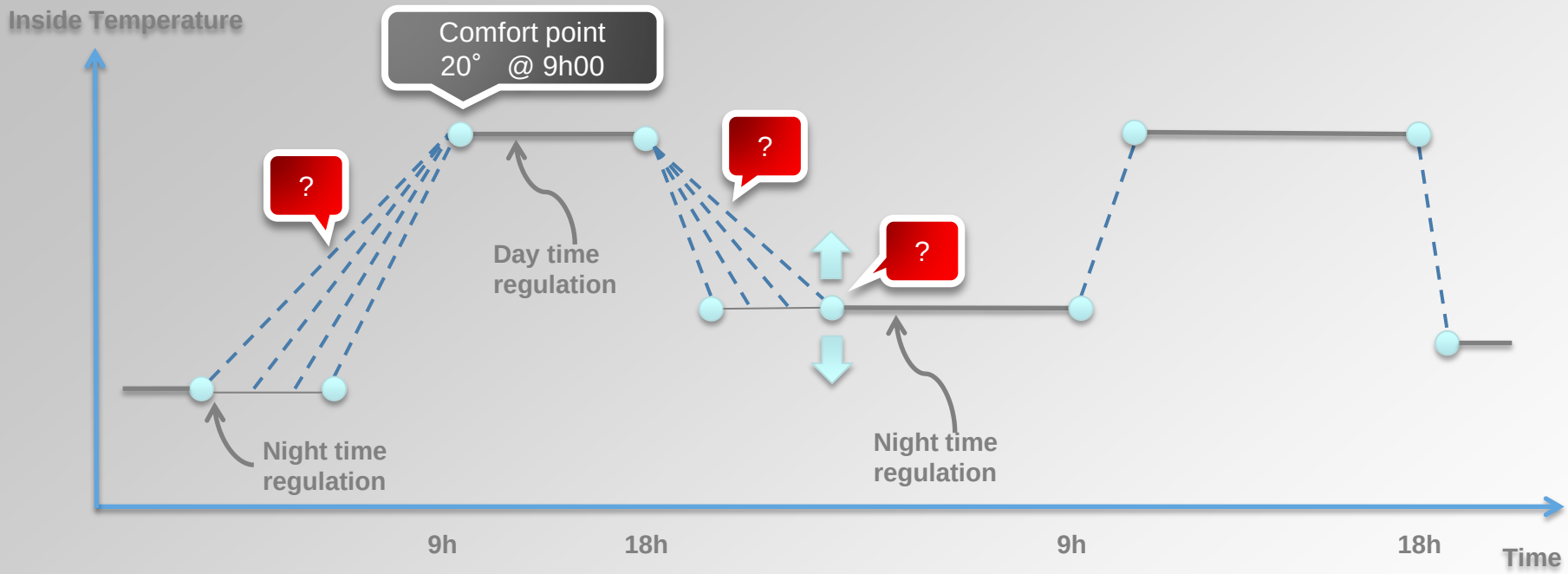


Control Agents

Select the best Context agent in order to apply its action proposition.



BUILDING INERTIA EXAMPLE

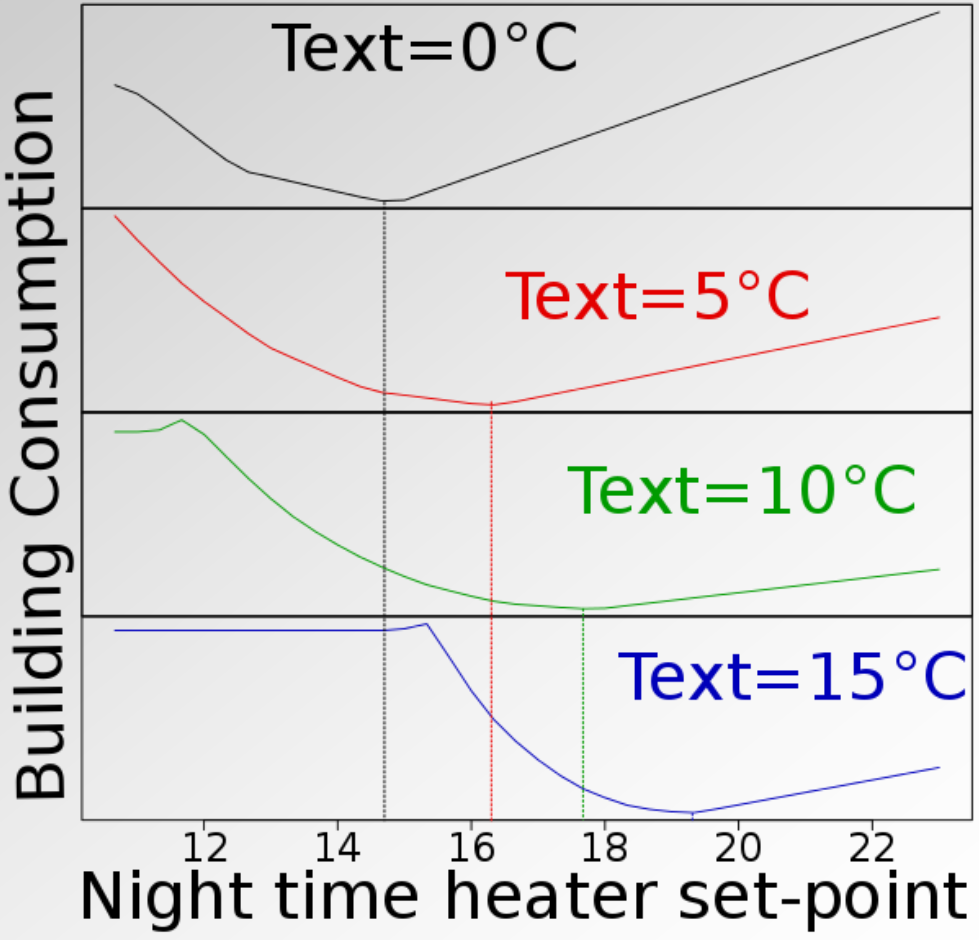


- Orders regulated by micro-ajustements at key moments
- Perpetual adjustments to building specificities and external factors
- Reduce consumption peaks

Optimal solution estimation

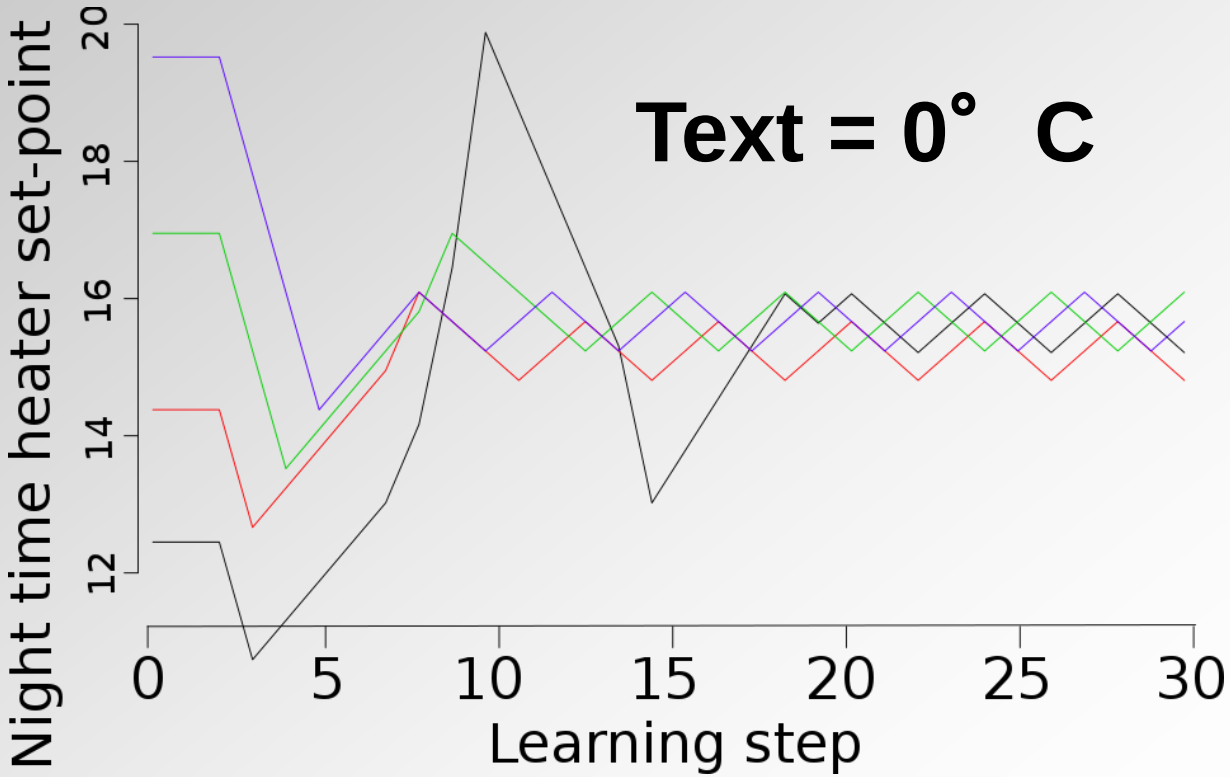
Exhaustive evaluation of night time set-point in four external temperature conditions.

Those results will be ignored by the multi-agent Saver. They serve as optimal references for evaluation of the Saver regulation proposals.



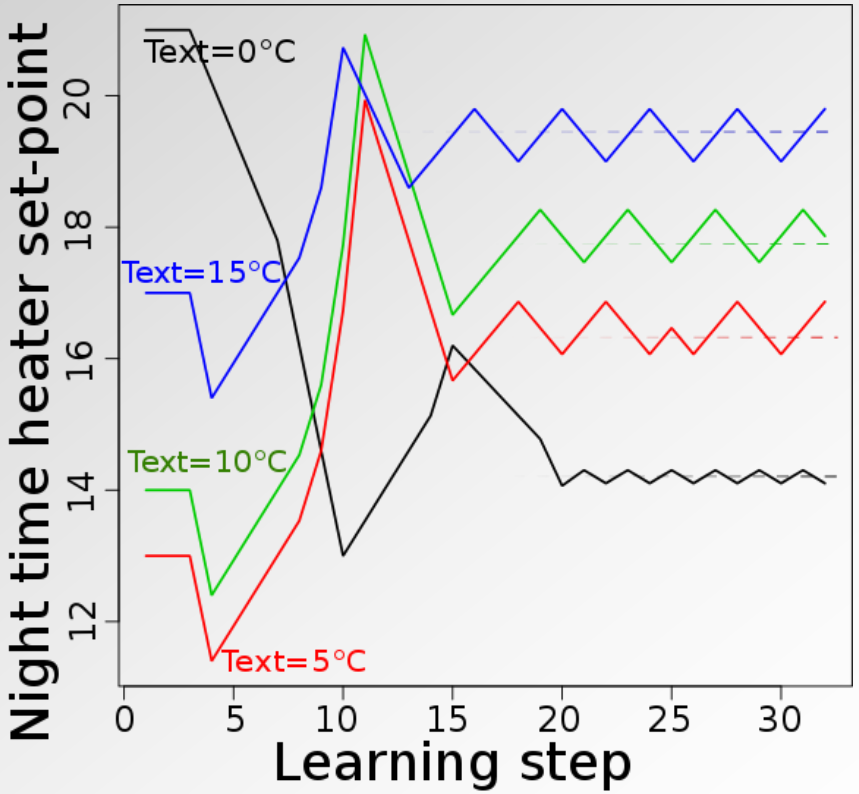
Experiment 1:From different initial points

From different initial points, Saver converge to the same final set point which is close to the optimal one.



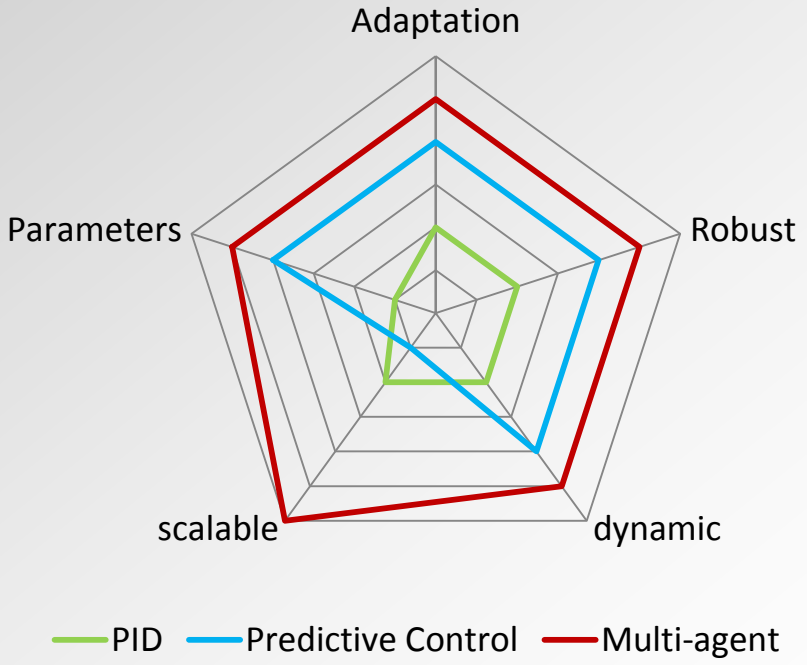
Exp 2: From different outside Temperature

For every outside condition considered, Saver successfully converge to different set-points which are close to the optimal ones.



Multi-Agent systems benefits

- The building is in a constant control and observation loop.
- Focus on the user needs.
- Open a way to cross domain solution.
- Give an understanding of building usage.
- Allow scalability.
- No mandatory model of the building.

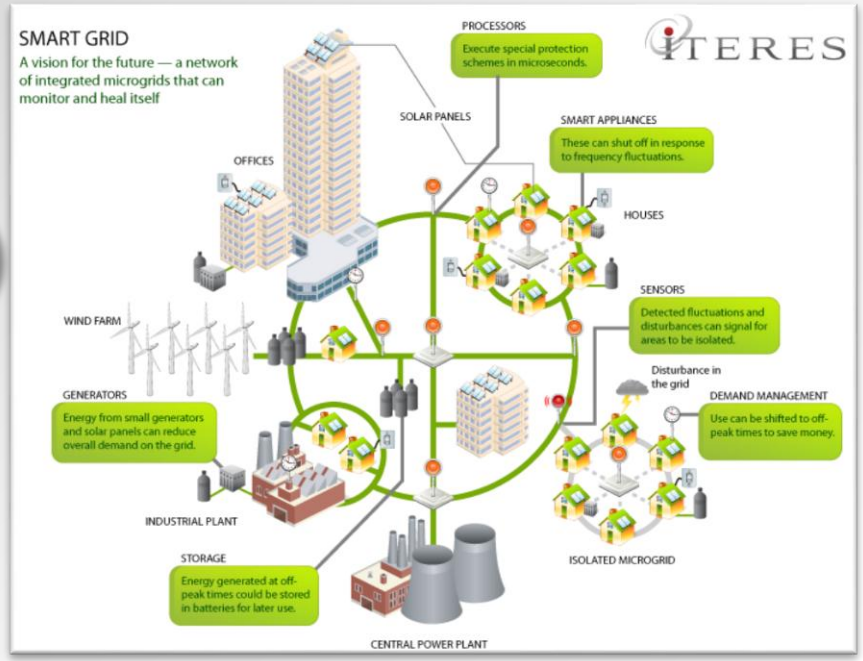


Adaptive	Dynamic
High number of parameters	Robust

PERSPECTIVES : SMART GRID

- **Consumption optimisation through Demand Response :**
  - Peak flattening
  - Adapt to the variability of the production

Expand to the scale of a city



Thank you for your attention

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