Efficient use of local energy

An activity oriented modeling to guide Demand Side Management

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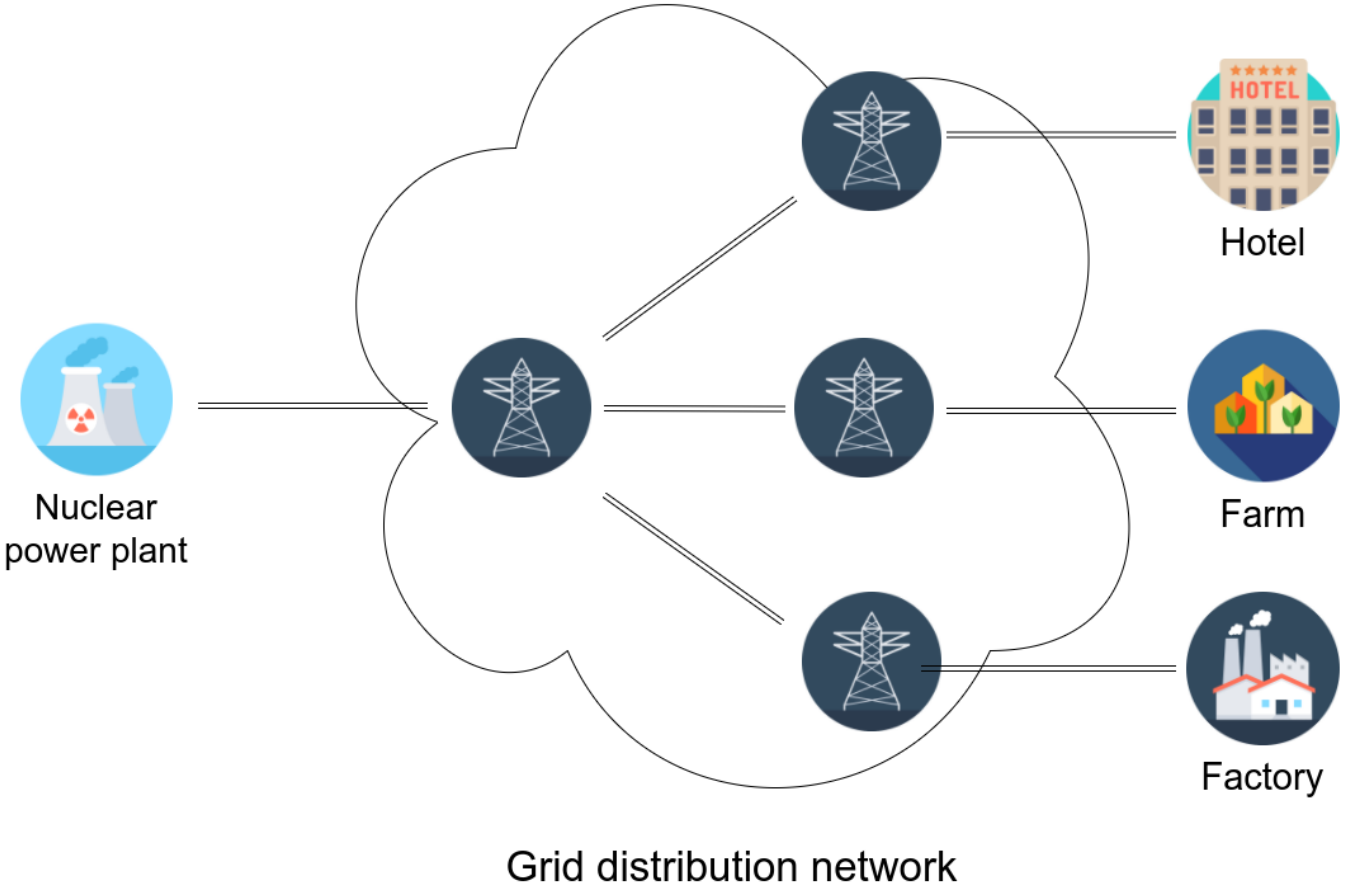
Grid architecture



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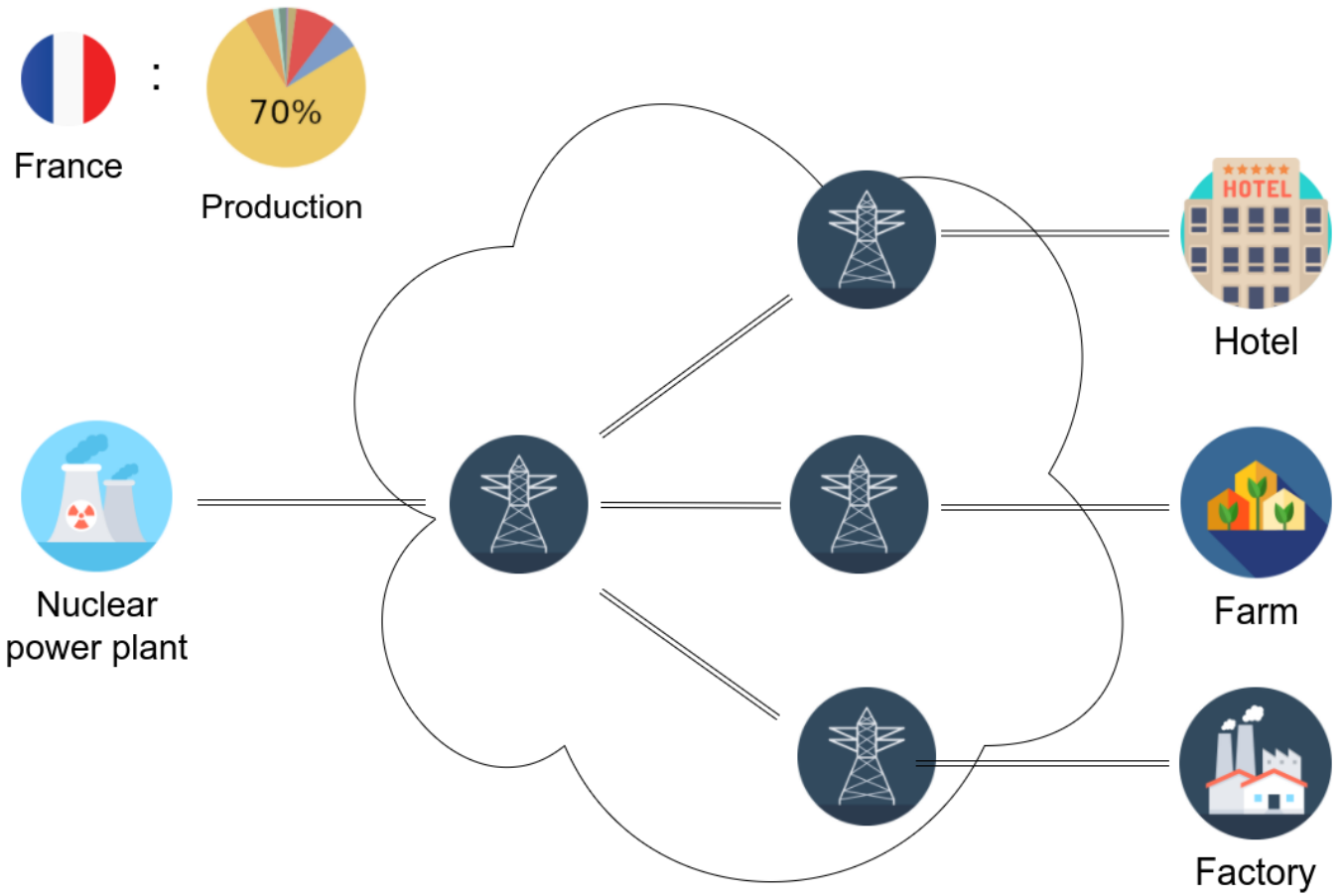
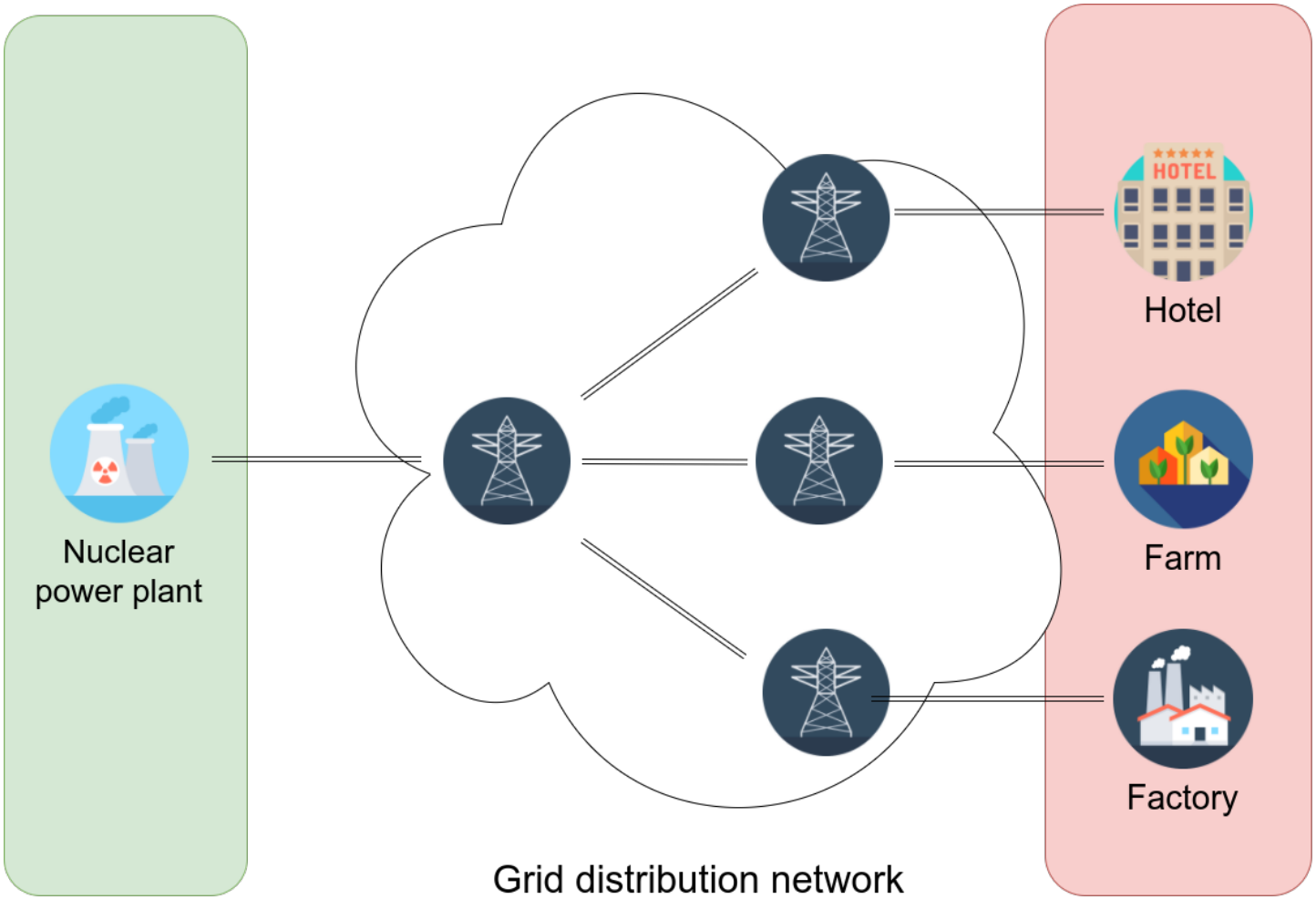


Grid distribution network

Centralized production



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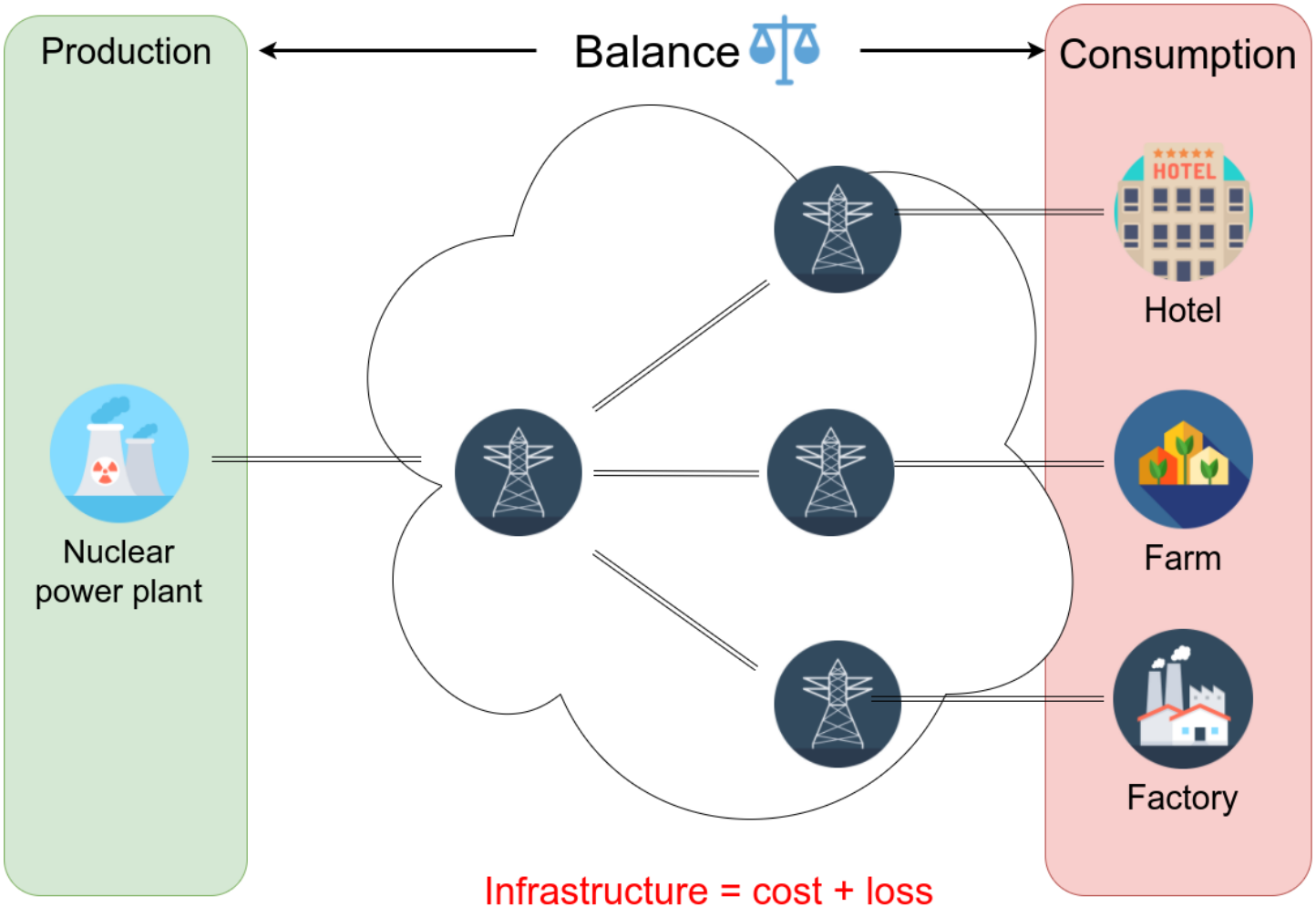
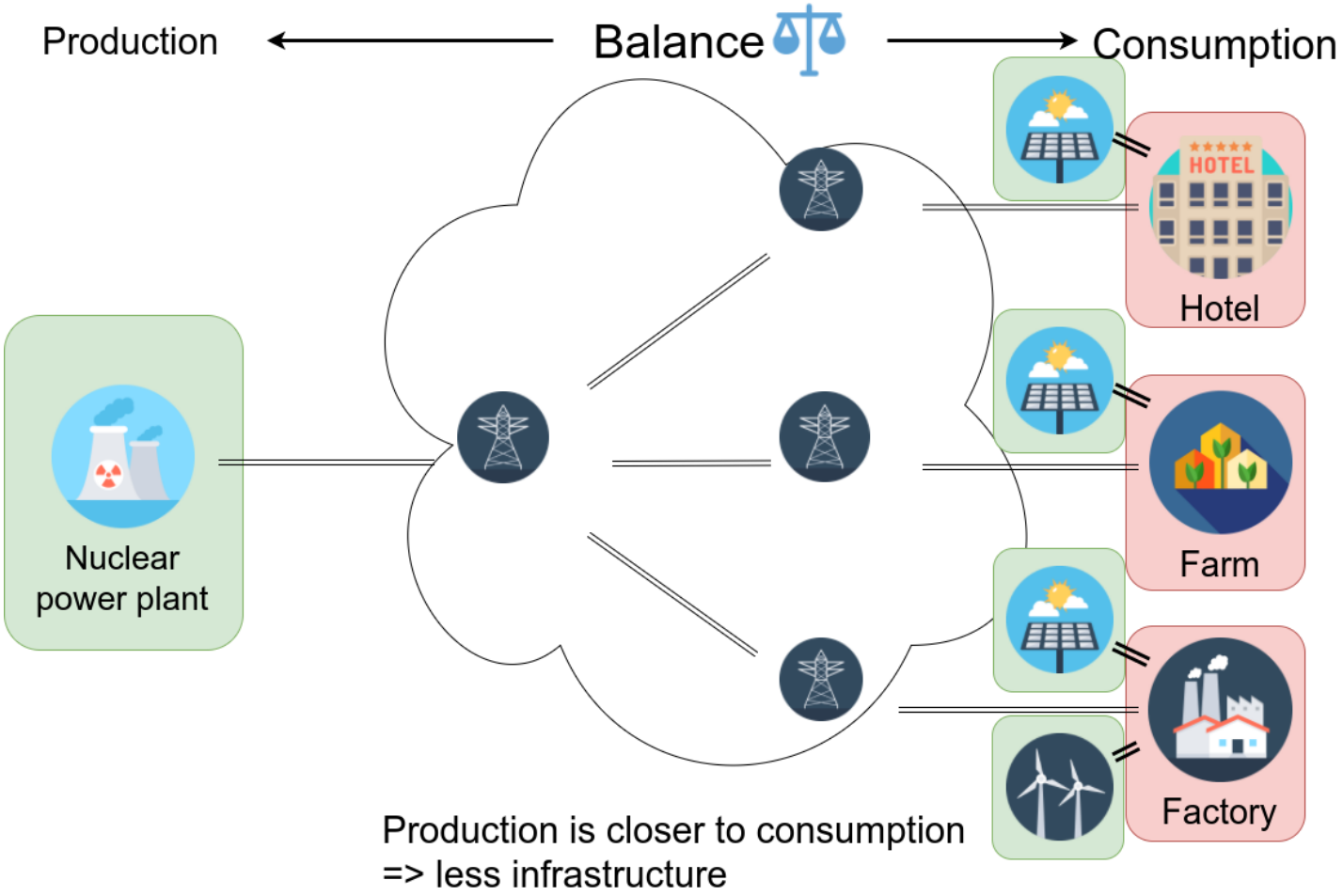


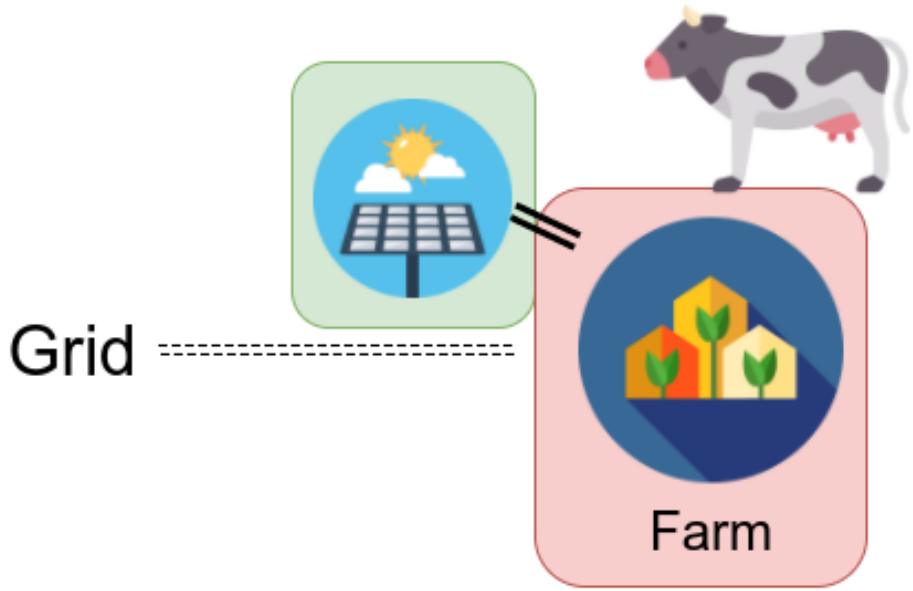
Decentralized production



Focus : real farms

Farmers are :

- Collaborative
- Big energy consumers
  (1 appliance ~ 60% of the daily consumption $\Longrightarrow$ easier for impact)
- at the edge of the infrastructure
  (blackouts)



Current situation

Curently : nuclear production drives the habits

Grid

"low consumption at night ? Low prices !"

With local production final users have more freedom.

(. . . and the economical aspect)

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Now we want to balance our local production with our consumption

Help industries increase their energy autonomy

Industrial site self-consumption

FIGURE – Dairy farm 60m^2 solar tracker

Self-consumption

- How much energy is **locally** used from production : $\frac{\text{used locally}}{\text{total production}}$

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FIGURE – Dairy farm 60m^2 solar tracker

Self-consumption

- How much energy is **locally** used from production : $\frac{\text{used locally}}{\text{total production}}$

Autonomy

- How much energy comes from local production : $\frac{\text{consumed local production}}{\text{total consumption}}$

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Current approach

State of the art does not focus on industrial processes (and residential is unpredictable)

At OKWind, we use :

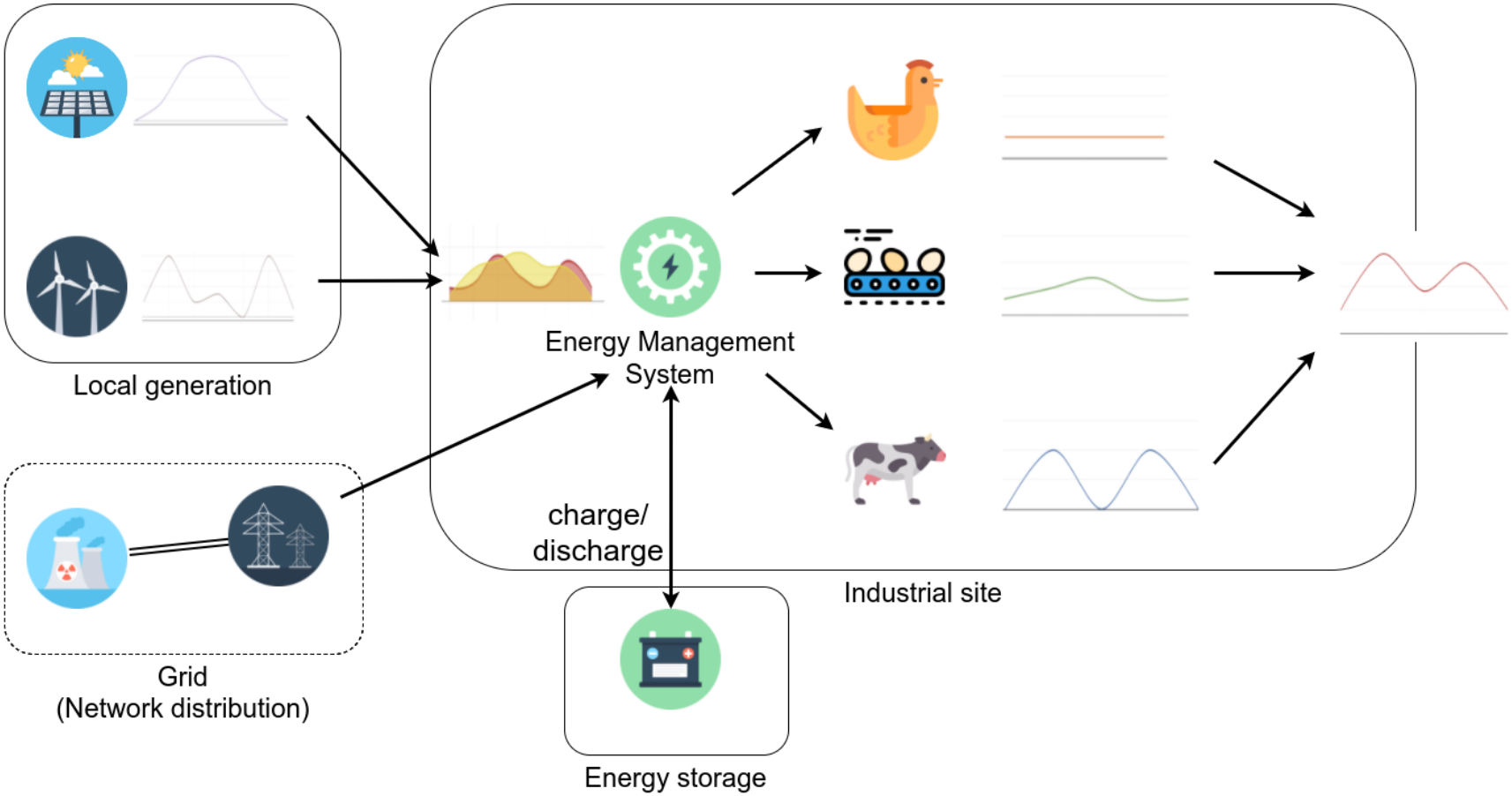
- spreadsheets,
- R scripts to analyze and simulate.

Limits :

- tedious work,
- complex decisions (e.g battery usage) are complicated to use,
- can't simulate >1 year in MS Excell

Need for more appropriate tools

Site overview



Alexandre RIO <alexandre.rio@okwind.fr>

Icons by Vectors Market from www.flaticon.com

Capture our concerns

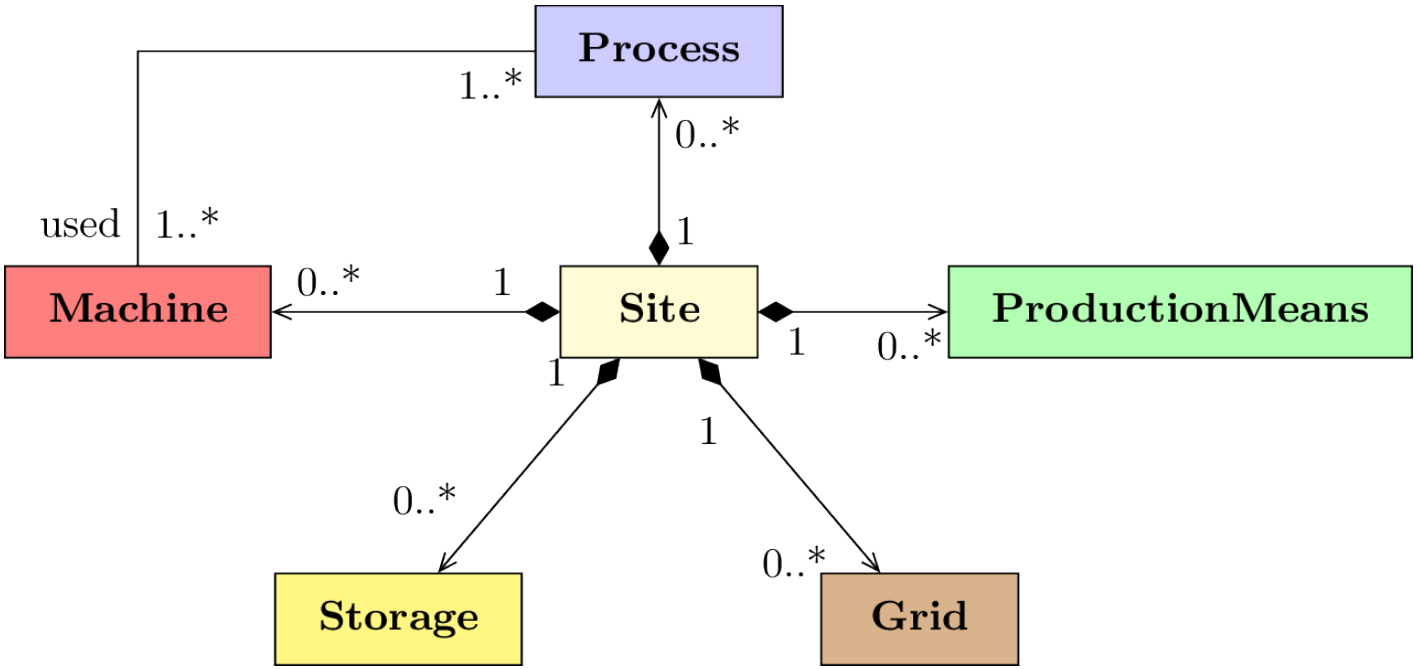


FIGURE – Metamodel simplified structure

Activity Oriented Modeling

Input for a **simulator** and a common language for domain experts

A DSL to represent a site, separating devices from activities
Devices can be defined :

- in the DSL,
- from a CSV
- externally, in Java, for complex behavior

Batteries can be defined with few attributes : inverter power, capacity, efficiency etc

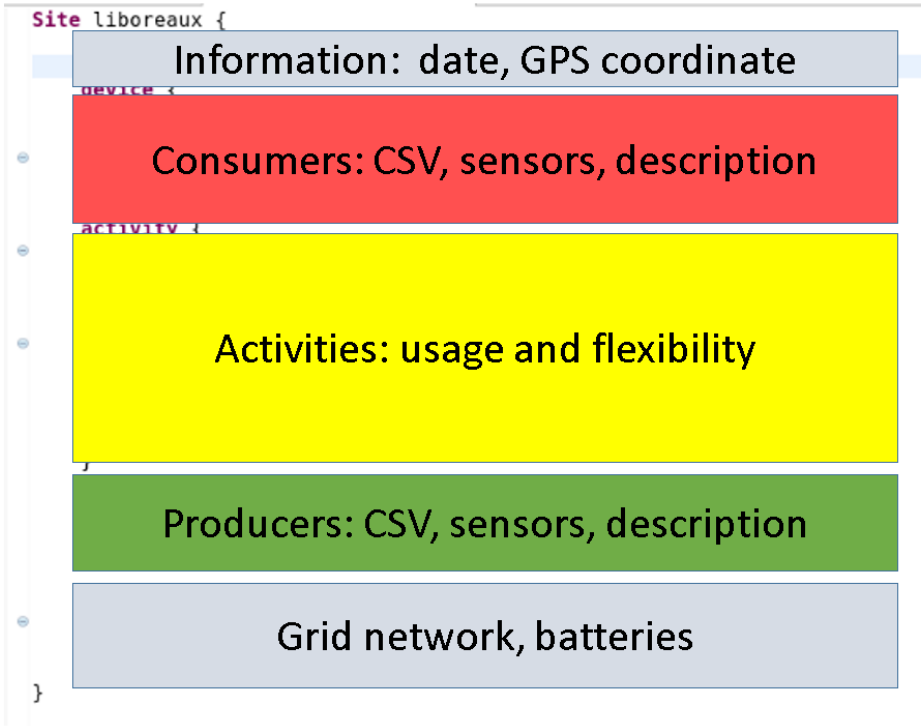


FIGURE – DSL example : 3 consumers in 2 activities, 1 producer

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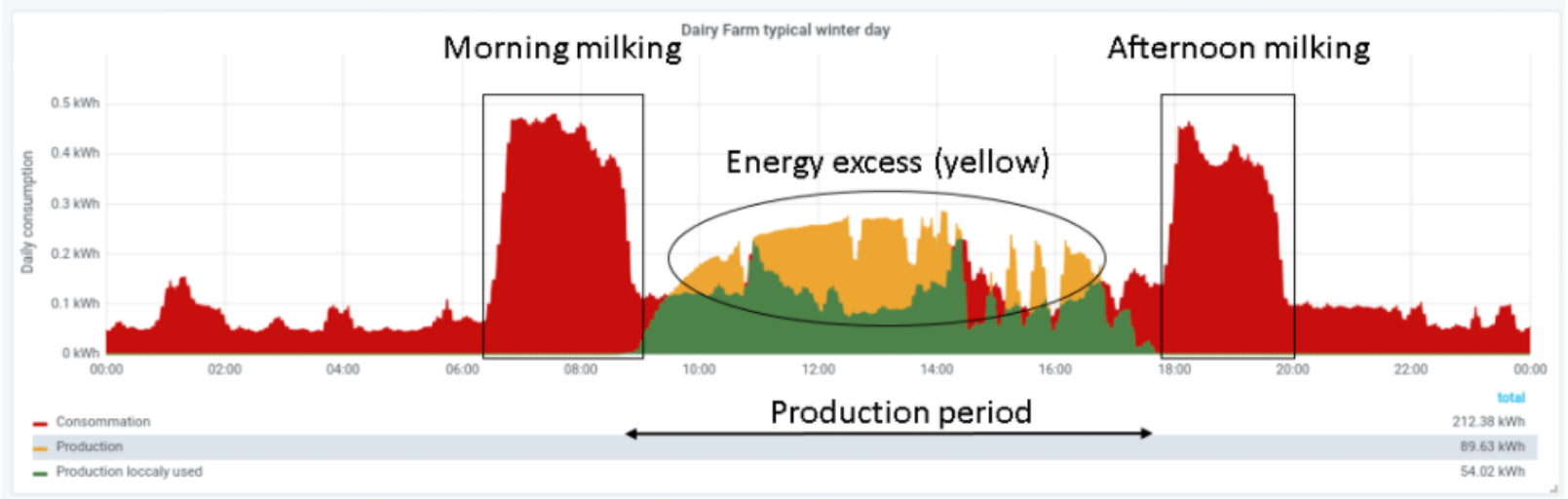
```
Site liboreaux {
    from 2018-01-20 to 2018-01-28

    device {
        Appliance liboreaux_conso_bruit as "plugin.timedcsvconsumer",
        Appliance liboreaux_conso_PAV as "plugin.timedcsvconsumer",
        Appliance liboreaux_conso_tank as "plugin.timedcsvconsumer"
    }

    activity {
        process bruit {
            device (liboreaux_conso_bruit, liboreaux_conso_tank)
            frequency Always
        },
        process pav {
            device (liboreaux_conso_PAV)
            frequency Always
            shift between 0 h and  3 h
        }
    }

    production {
        Producer liboreaux_110m290BiSunSW as "plugin.timedcsvproducer"
    }

    grid {
        Grid edf as "edf.bleu"
    }

}
```

FIGURE – DSL example : 3 consumers in 2 activities, 1 producer

In terms of energy : current situation

With no control

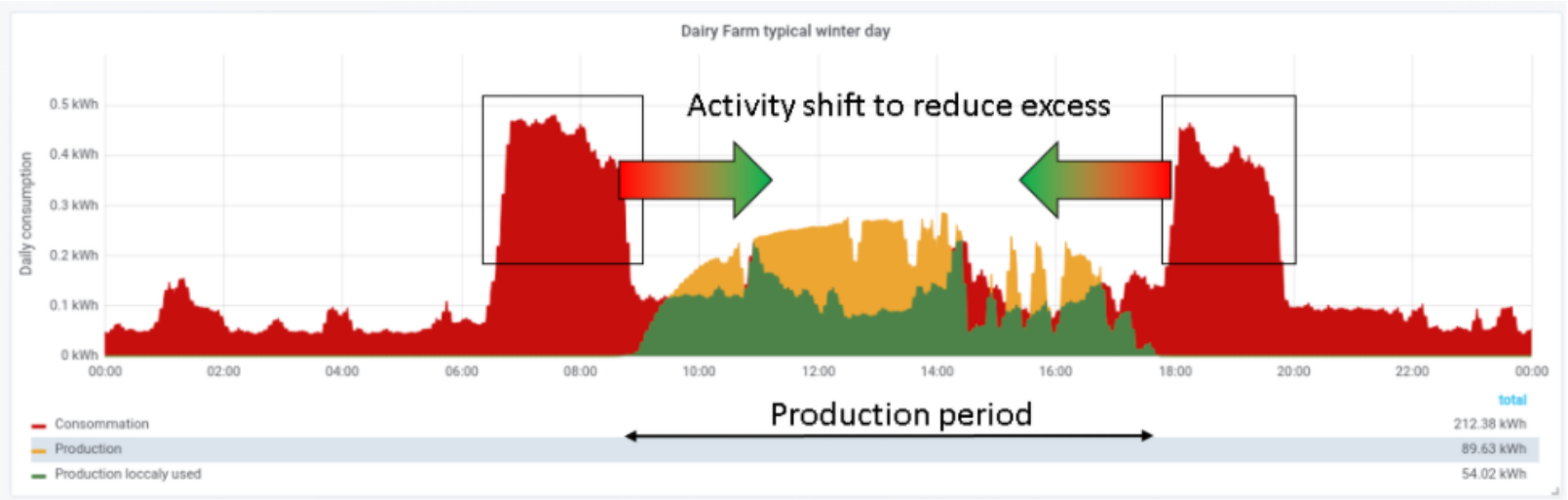
Energy excess goes back to the distribution network



In terms of energy : a better situation

Demand side management

Actions, client side, to increase energy efficiency



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Answers for scenarios

Experts want to answer various questions :

What-if :

- What if I shift my morning activity two hours after ?
- What if I double my local production ?

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What-for :

- What is the best storage capacity for 50% autonomy ?
- Which region allows the best autonomy for my activity domain ?

Usage

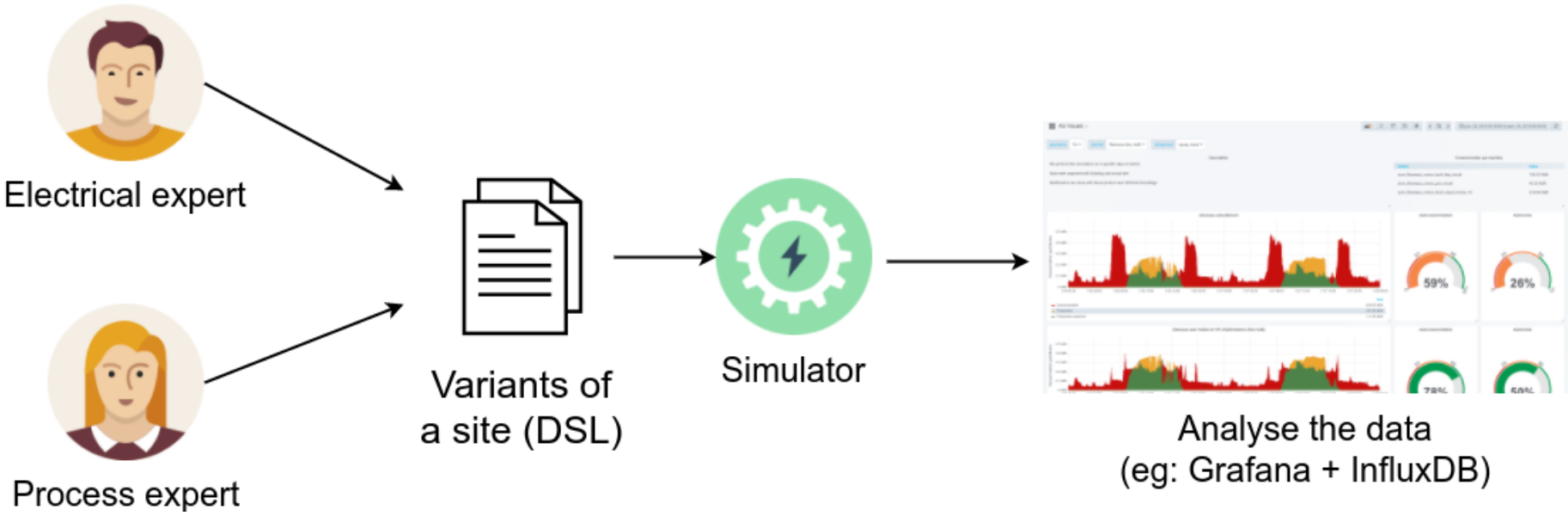


FIGURE – Experts express their concerns using the same DSL and can simulate various scenarios

Use case 1 : variability

Capture variability and apply scheduling algorithm

- activities schedule (start, end)
- dependencies and recurrences

Actions :

- Delay a task
- Act on the intensity

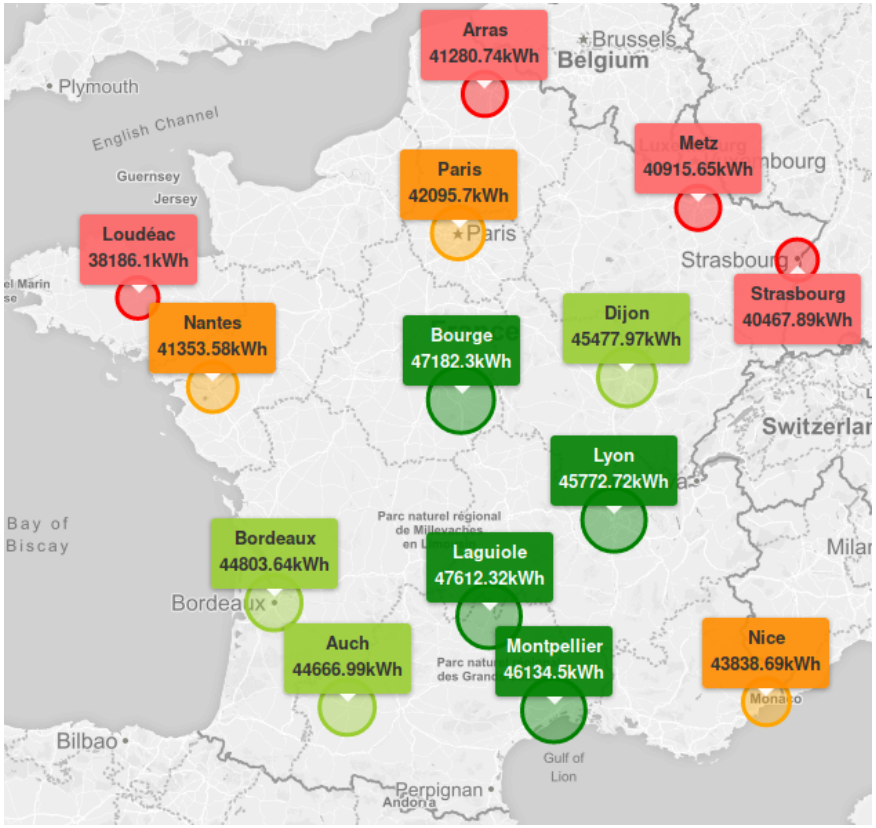
Help us identify where to focus, effort/effect

```
process Cleaning(WaterPump, Lights) {
    after (Milking) // Dependency
    frequency Periodic
        at 10:00
        for 1 h
        on days {MONDAY, TUESDAY}
    shift between 0 h and 2 h // Flexibility
}
```

Use case 2 : sizing

- Leave the consumption as is,
- try various combination or producers,
- various battery specifications

Economical quick pre-analysis



Future work

In progress :

- We are using the simulator in real-time with power sensors and battery API as an Energy Management System
- We're extending our model to include simulation run (EXE) details
- Benchmark scheduling algorithm to find best demand side actions

Summary

Industrial

- base for common language (shift, profile distortion),
- automated tools to size production and storage devices

Academic

- Propose a model including all different aspects, from production to consumption,
- Model for industrial processes flexibility exploration
- Benchmarking platform for energy-related scheduling algorithms

Questions ?