



ZAGREB 20/09/18



A bit of history of Tuscany

Tuscany is famous principally for



**But there is also another thing that make Tuscany famous
all around the World**

GEOTHERMY





GEO THERMY: HOW IS WORKING TODAY

From the physical aspects to the level of automation

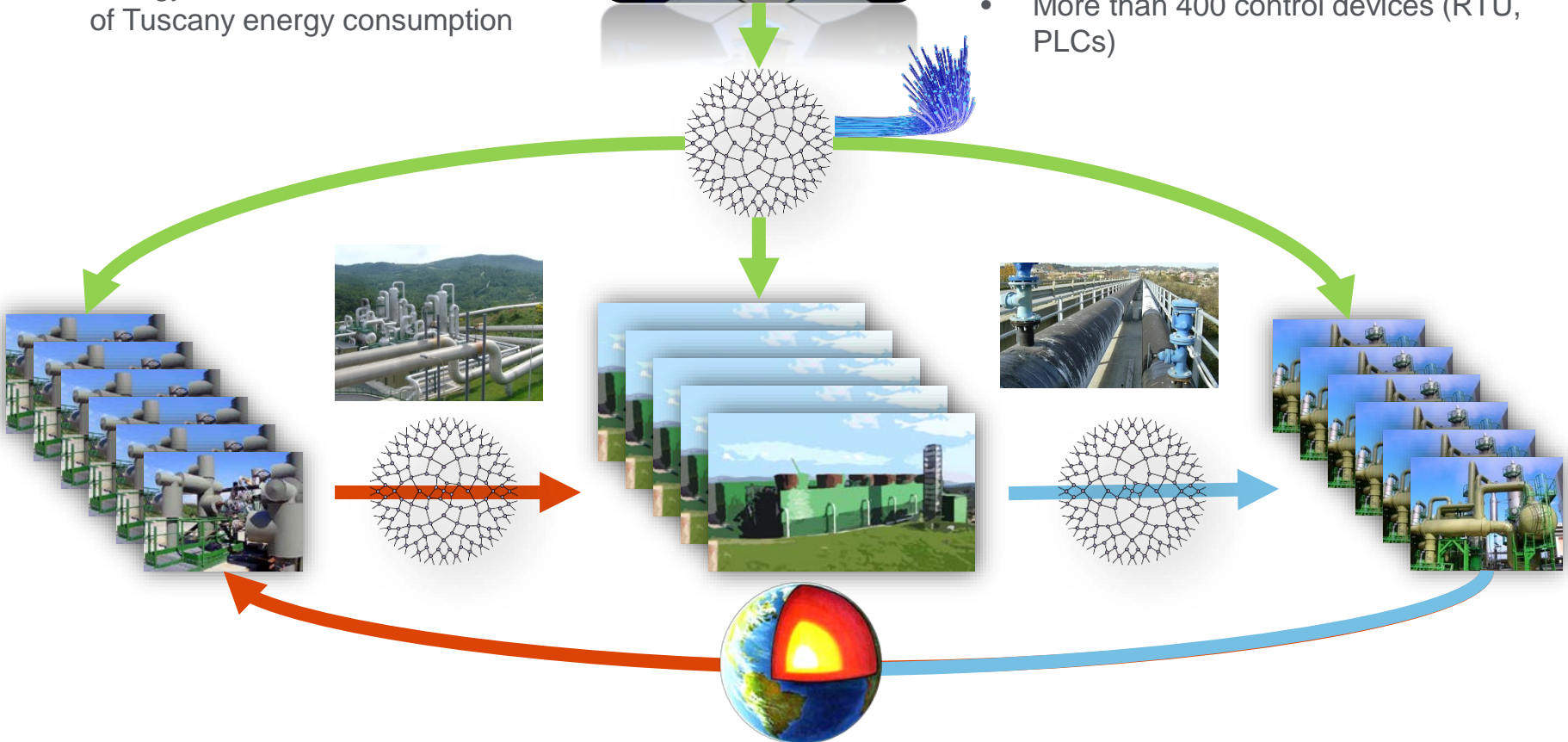
The physical number:

- 761,2 MW Net reference capacity
- 37 Power Units
- Total wells n. 503
- Energy Production more than 30 % of Tuscany energy consumption



The level of automation:

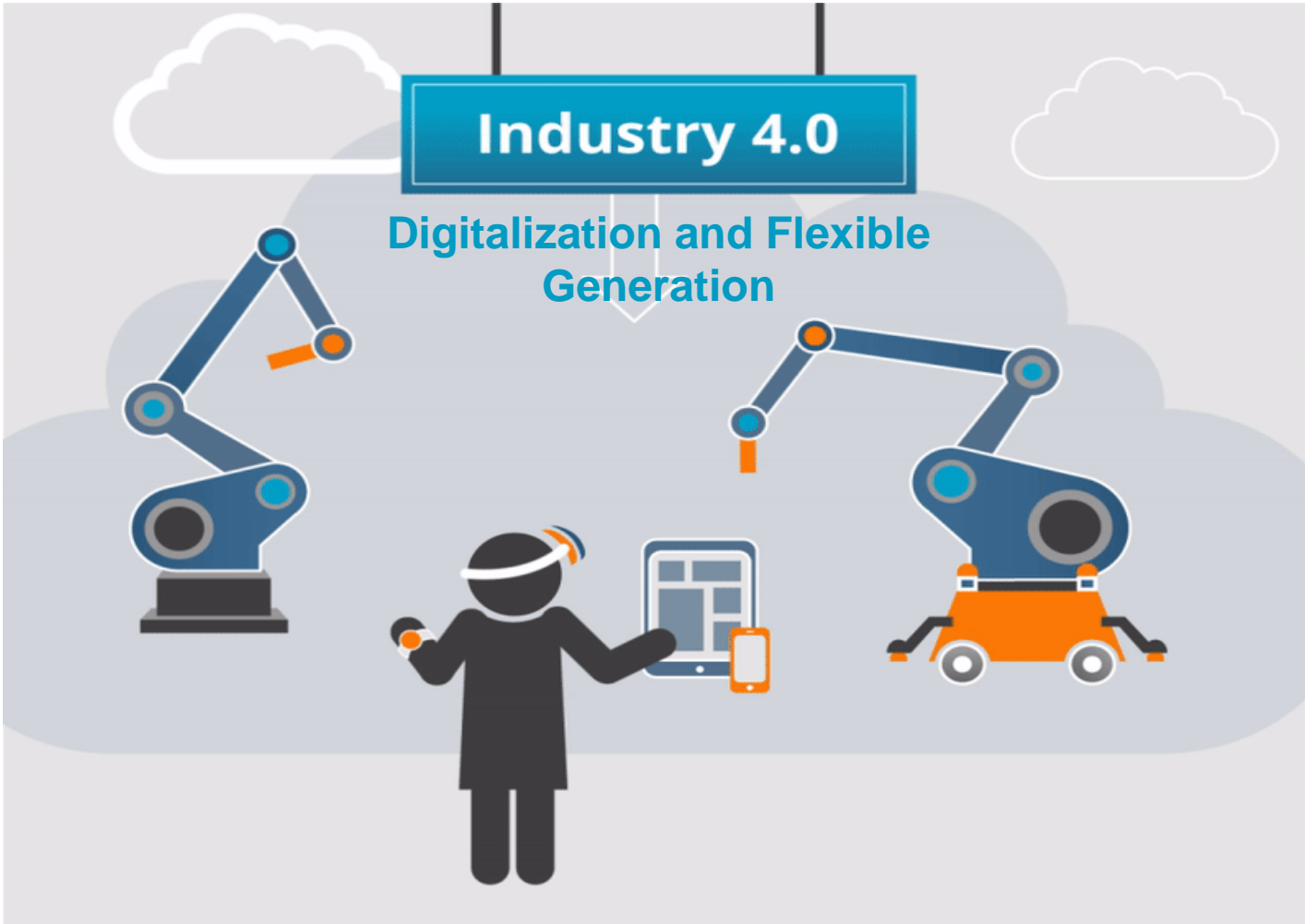
- None of the plants is normally manned
- A tele control centre that controls and monitors all the plants
- More than 400 control devices (RTU, PLCs)





Technology

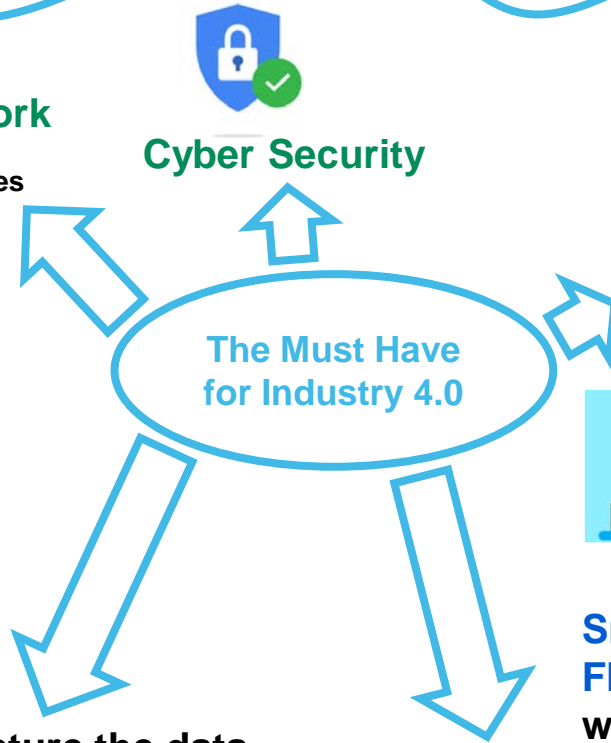
The evolution over the year





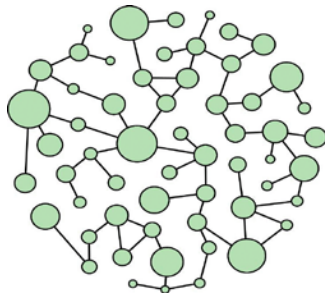
Reaching the 4.0 industry thanks to SmartGEO

Starting from the current technological bases in Geothermy



Fast and reliable network

- 350km of optic fiber
- More than 200 network devices



Cyber Security

SmartGEO:

Increase monitoring: increase the diagnostic capacity with innovative technologies

Data acquisition devices

- 50000 sensors installed in the field



SmartGEO:

Flexible control: efficiency increase with high level algorithms

Data Analysis and process control

- Tele diagnostics platforms for easy calculations
- Tele control platforms for power plant monitoring and remote control



SmartGEO:

Digital twin: structure the data

Large amount of data available

- 12 years of acquired data





SMART-GEO

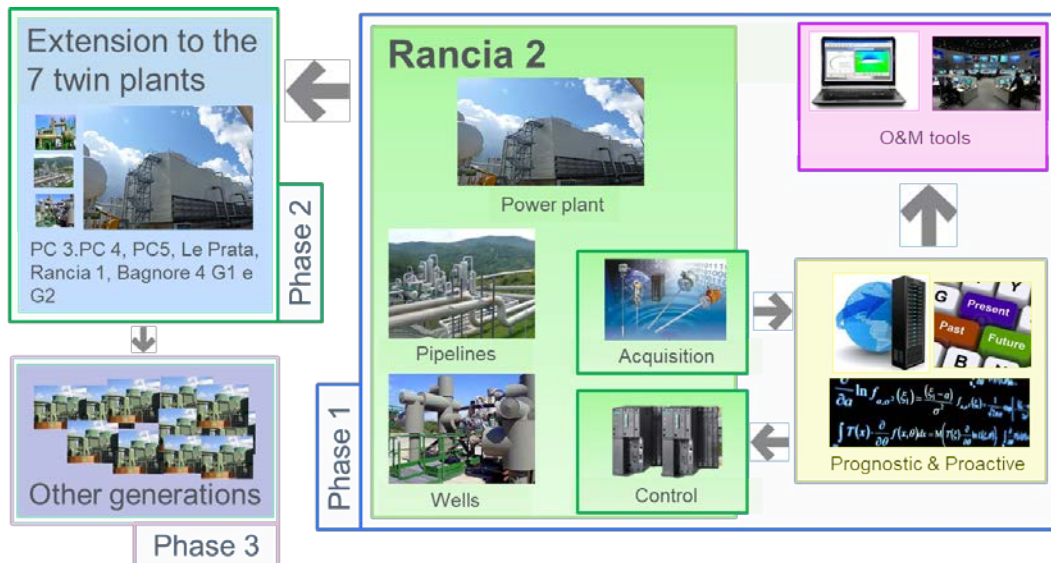
A project co-financed by POR FESR for the period from 01/17 to 03/19

Objective:

Prototyping, development and commissioning of advanced and innovative technological solutions of prognostic and control on the "Rancia 2" Geothermal Plant and on the structures connected to it (wells, steam nets, steam washing systems, re-injections)

- ✓ **Increase the monitoring level** of the Geothermal systems connected to Rancia 2
- ✓ **Develop new advanced analysis system** and integrate it with the existing one in a unique integrated monitoring and diagnostic platform
- ✓ **Increase the production efficiency** of the pilot plant through innovative and modern control and diagnostic analysis techniques

Scalability:



Partners:

- SUPERIOR SCHOOL OF SAN'ANNA PISA
- UNIVERSITY OF FLORENCE
- ENEL GREEN POWER: renewables energy utilities
- ISE: industrial processes control, analysis and monitoring
- SDI: HMI, PLC production and programming



The SmartGEO industry 4.0 approach flow from the acquisition to the flexible control and optimization of the production process



KANT:

New asset monitoring with innovative and traditional instruments and systems

HISTORICAL DATA:

Process information automatically acquired through devices in the plant



DIGITAL TWIN:

From the physical devices to their corresponding digital representation



DIANA SOFT REAL-TIME:

Develop, test and release innovative algorithms for high level systems flexible control and monitoring



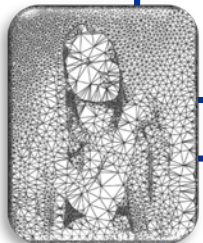
DIANA HARD REAL-TIME:

Develop, test and release innovative algorithms for low level power plants flexible control and monitoring



USABLE VISUALIZATION TOOLS:

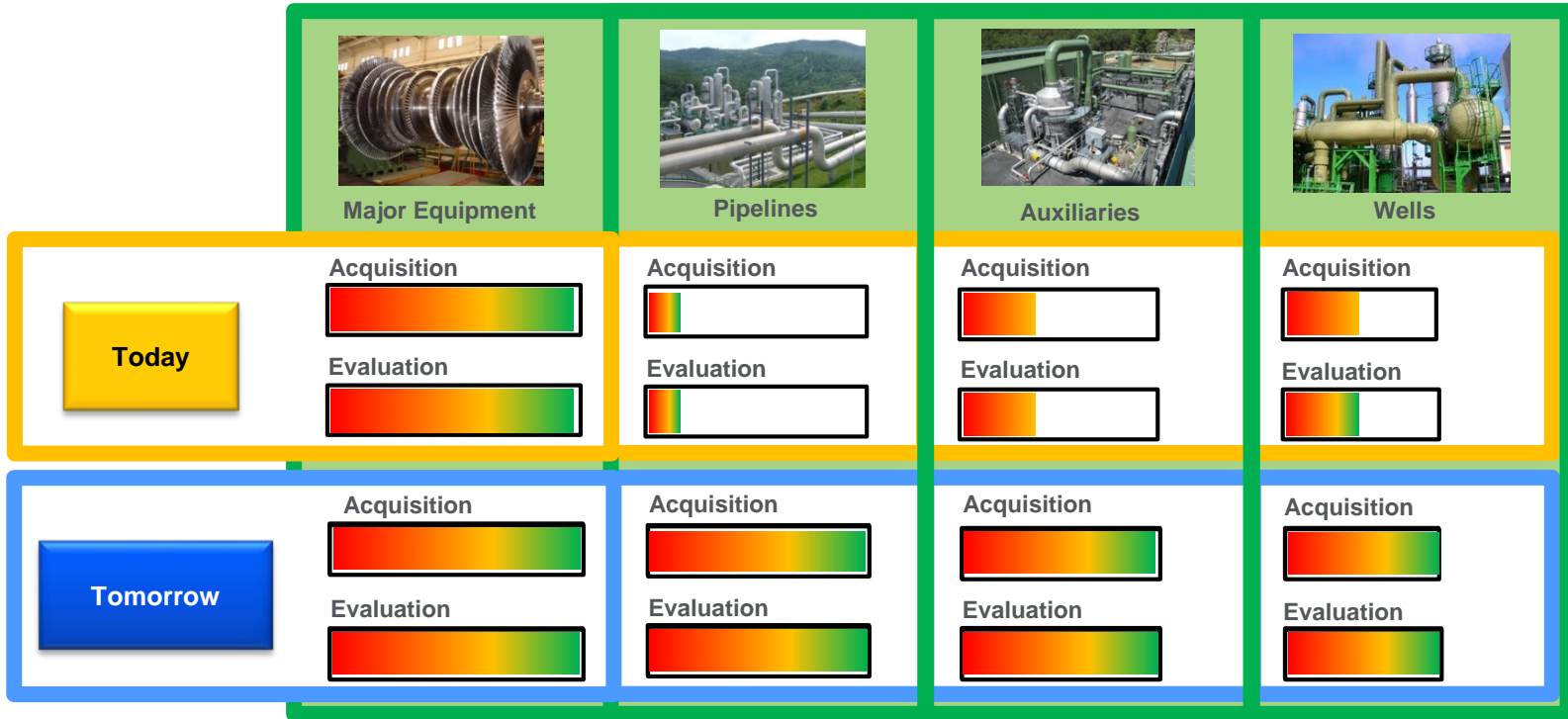
Extract and display the analysis through simple and highly informative tools and indexes and let them accessible also from mobile devices





Kant

increase in Acquisition and Evaluation capacity



Advantages:

- ✓ The more data we acquire from the field the more evaluation capacity we have





DIGITAL TWIN

Digital modelling of physical components



Advantages:

- ✓ Ease of research and monitoring of plant components
- ✓ Full and detailed description of each component
- ✓ Hierarchical organization of plant components





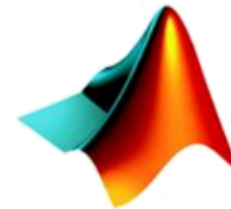
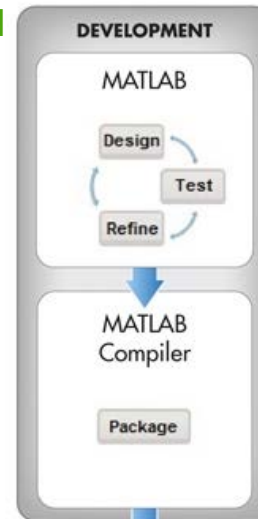
DIANA: SOFT REALTIME ARCHITECTURE

High level algorithms development and training phase

Advantages:

- ✓ Data scientists friendly platform
- ✓ Matlab have a great variety of tools, mathematical features, data analysis and process control techniques
- ✓ Matlab is a common language in the scientific universities
- ✓ Extreme scalability of the solution
- ✓ Native integration with our traditional Osisoft Historian database

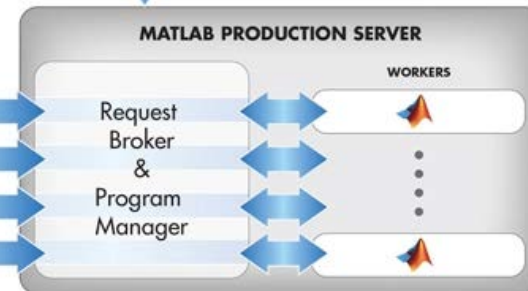
Training & Development MAINFRAME



MATLAB®



Process HISTORIAN



Release & production
MAINFRAME





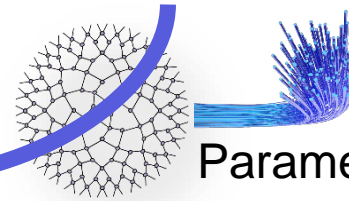
DIANA: HARD REALTIME ARCHITECTURE

Process Optimization and Control

Advantages:

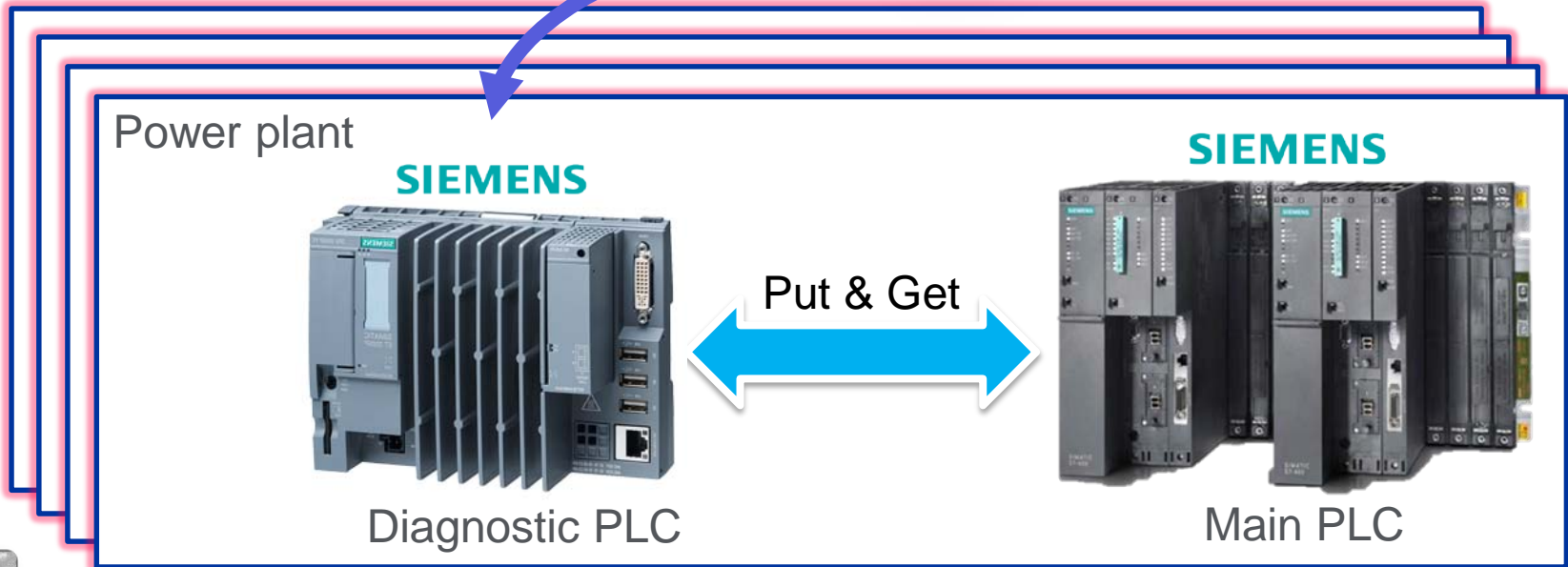
- ✓ Proactive interventions on plant control
- ✓ Prognostic and prevent inefficiency events
- ✓ Avoid blocks for breakages and anomalies
- ✓ Flexible control of the energy production

Training & Development
MAINFRAME



Parameters update

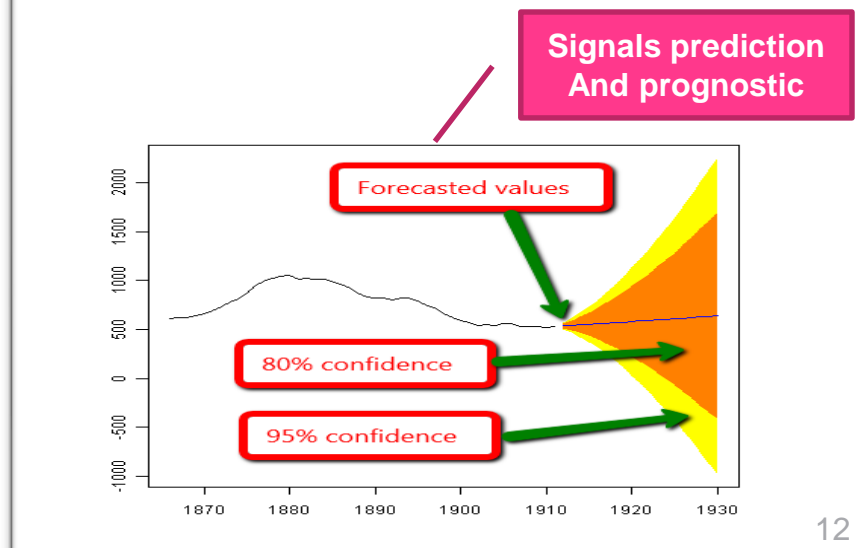
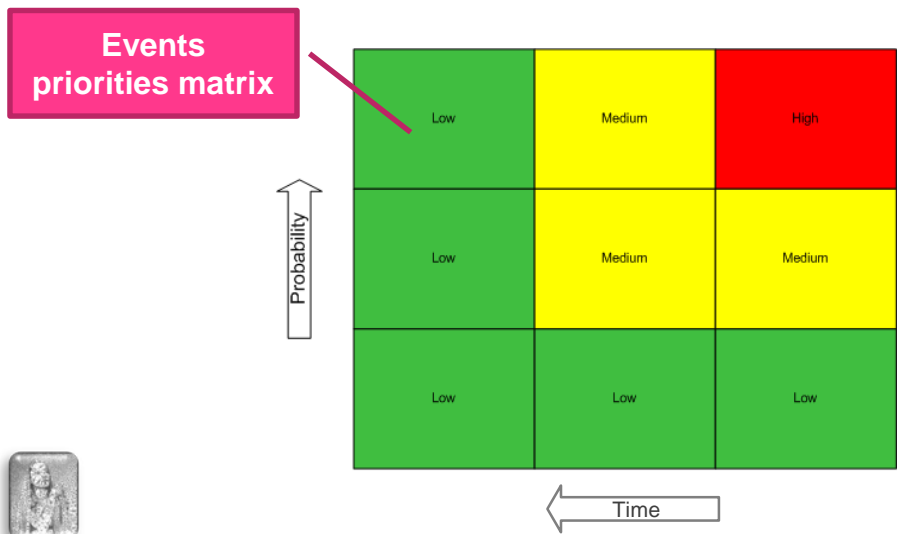
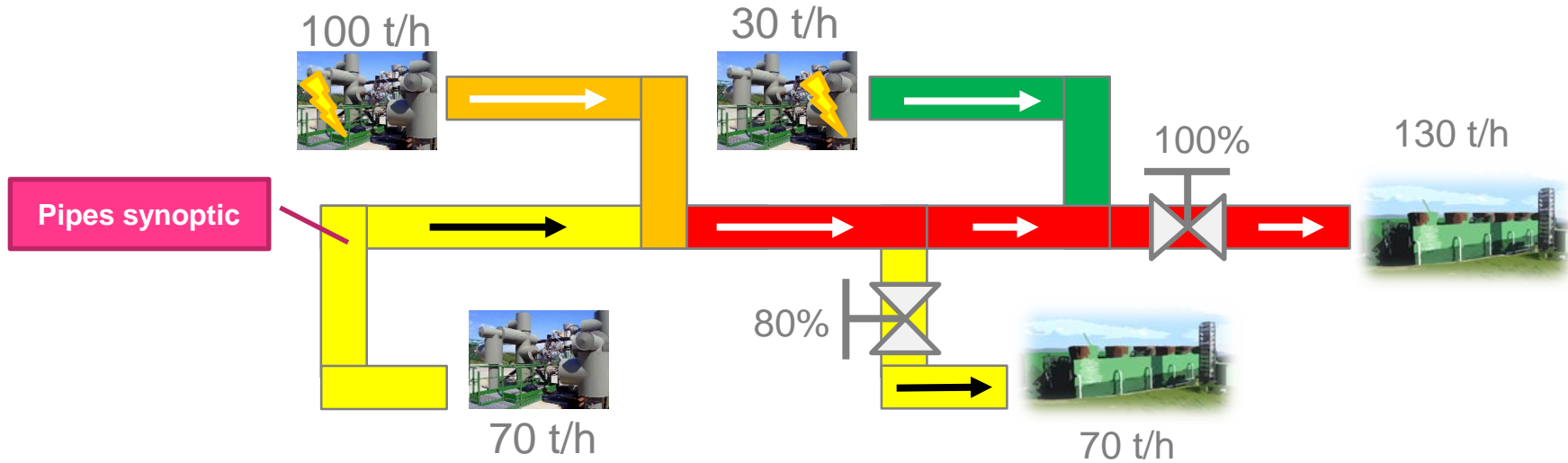
Scale to many control systems





Presentation of the analysis

User and mobile friendly extrapolation of the analysis results





Project Key exploitable results

Horizontal results for scientific, societal or economic purposes



- Ecosystem for development and release of **complex mathematical/physical/statistical analysis** in a robust and integrated way: [Industry 4.0 platform for high level optimization algorithms](#)
- Increase the **digital culture** among employees: [increase and consolidation of experience in the use of daily digital analysis tools and services](#)
- **Diagnostic PLC** as a complex analysis add-on to the main PLC: [real-time device with the capability to run complex algorithms independently to the main PLC.](#)
- Developed solution that enables the potential of **data scientists** high level solutions: [analyse the data deeper in order to increase the production and procedures efficiency](#)



Project Key exploitable results

Vertical results for the geothermal field

- Flexible control and monitoring of the **energy produced**: a synoptic of the steam flow situation increase the capacity to redirect the flows in order to optimize the revenue and the power production
- Increase **auxiliaries monitoring**: avoid the accidental blocks and breakages
- New specific **diagnostic tools** for technicians: easy and high informative indexes for the power plant monitoring





The lesson learnt, the barriers and the risks that can slow down or block achievement of goals

- **Geothermal industry is a niche market:**

Limited literature solutions and benchmarks to follow for innovating the process. The risks to be pioneers

- **High value of data acquired:**

The huge quantity of data acquired have a big potential to be used for increase the productivity

- **High effort for structure data for the analysis:**

The process in which we filter and label the data is not effort free

- **The importance of guarantee a robust and informative measurement chain:**

High complex calculus need a robust input to work well and be utilized with confidence

- **Process knowledge needed for the high level algorithms developing:**

Impossible to work independently among the technicians and the data scientists

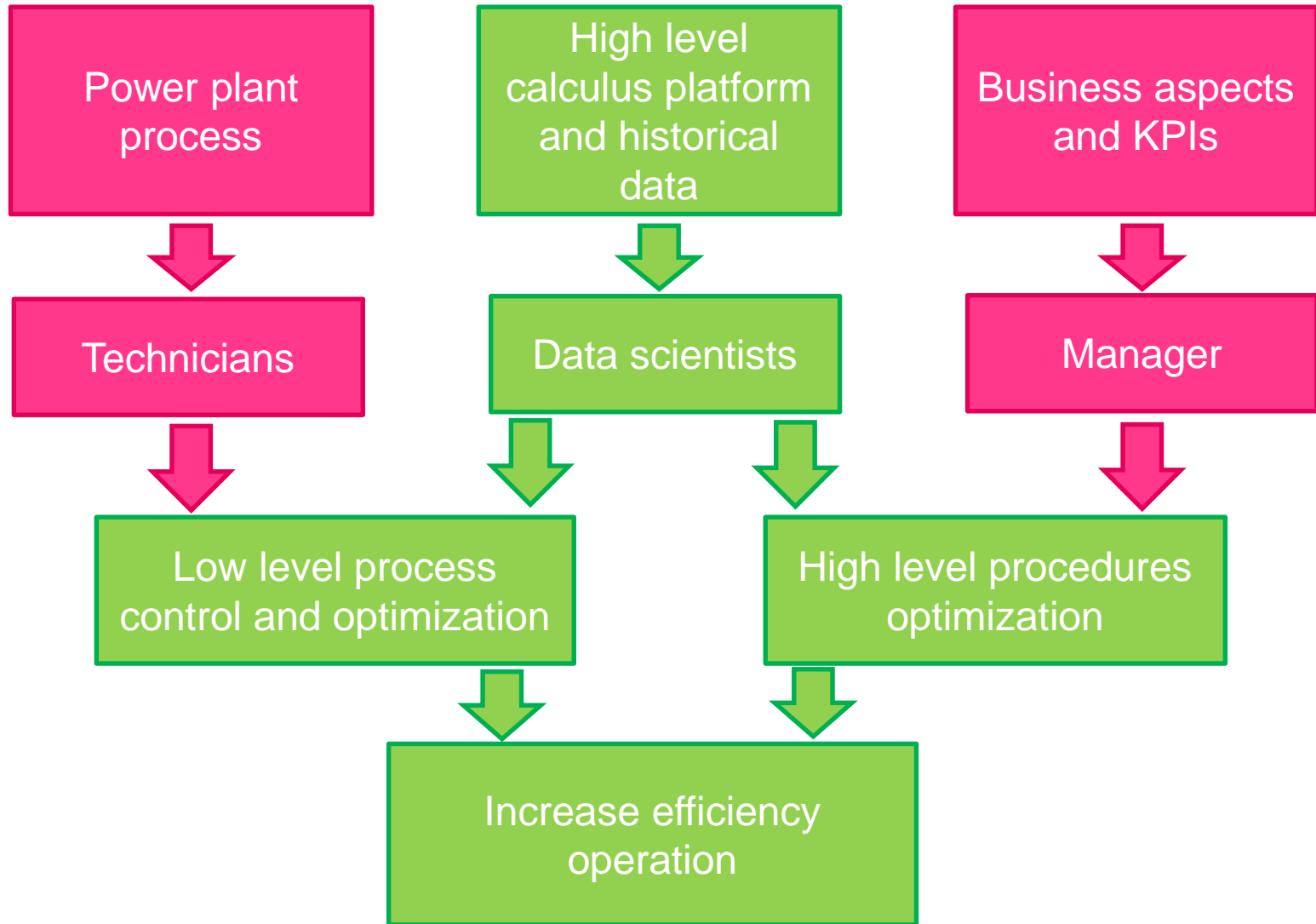
- **Design an high scalable central system for complex calculus :**

High parallelization scheduler for data flow management



Future prospects

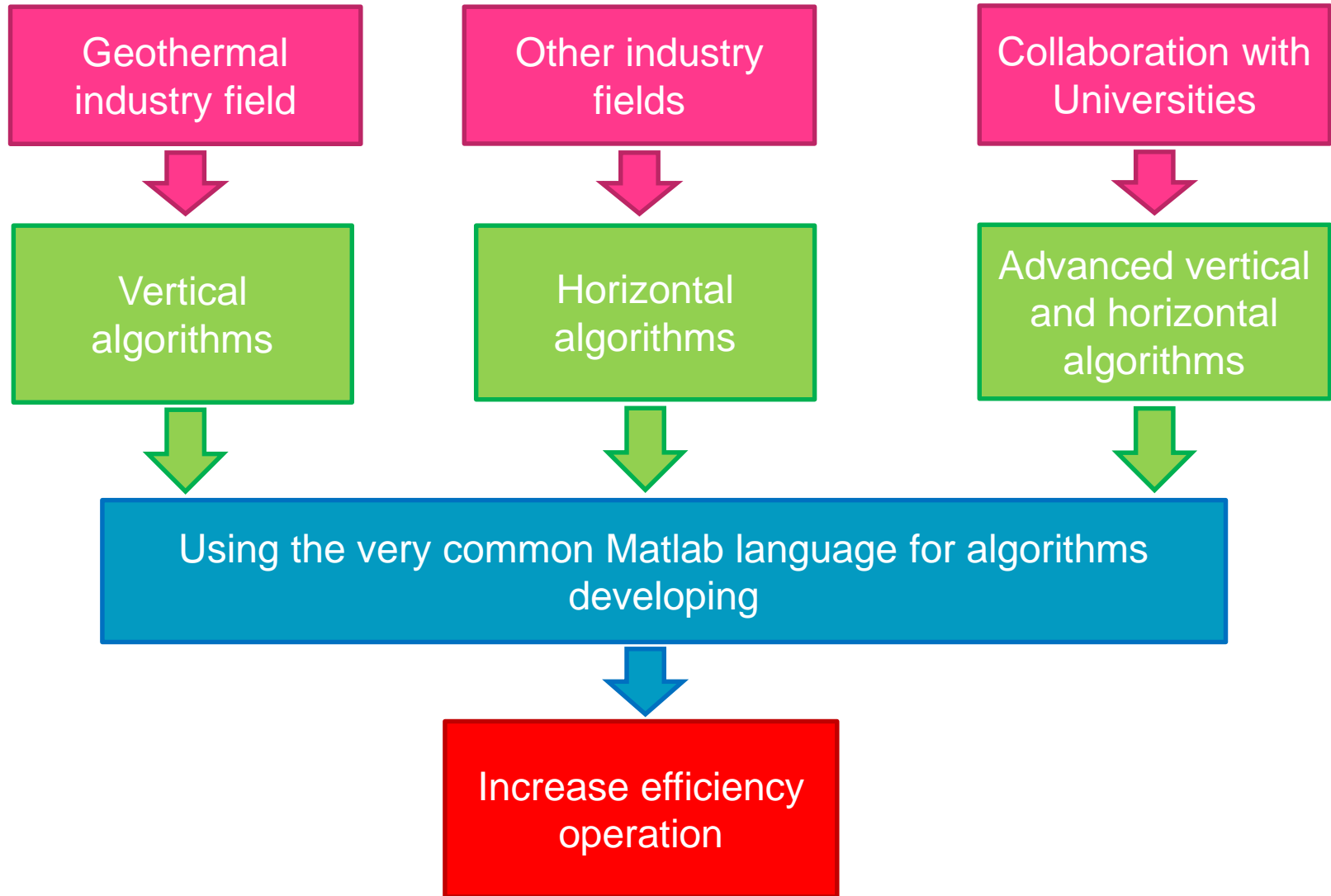
Needs for future R&I activities coming out of the project





Industries and Universities collaboration

Three possible cooperation scenario



THANK YOU VERY MUCH



KANT: LUMAGA

convert thermal energy directly into electricity



Advantages:

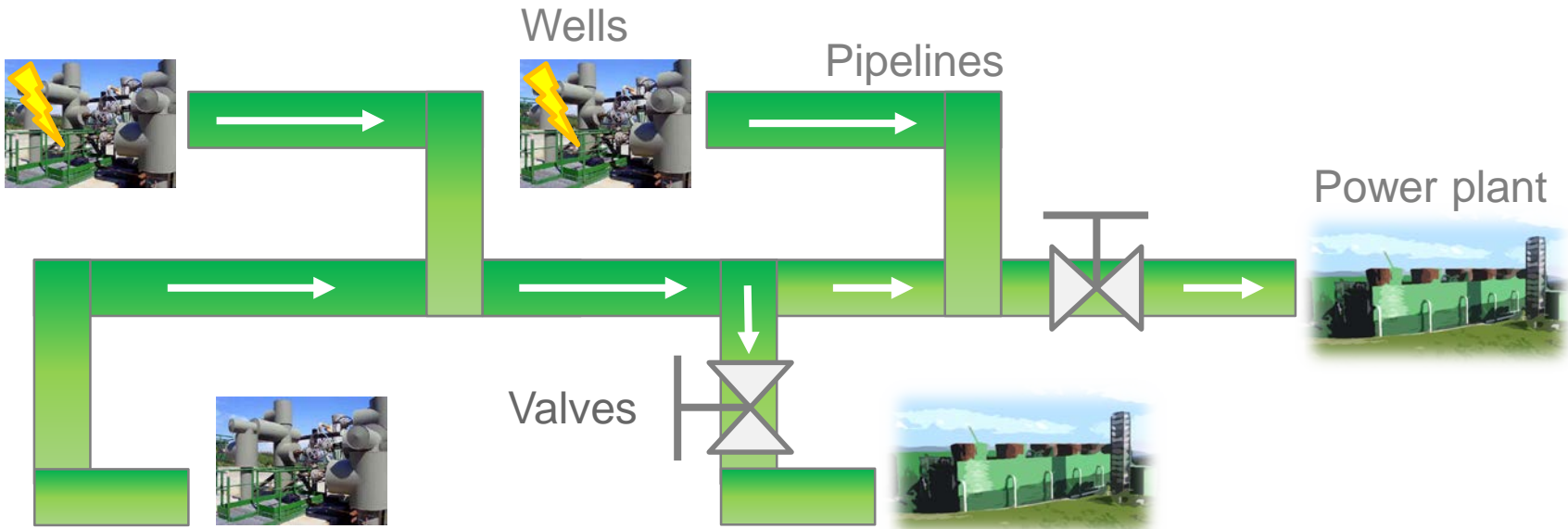
- ✓ Create electricity in isolated areas
- ✓ Modular use based on the need for energy
- ✓ 100% capacity factor (20% solar panels)
- ✓ MTBF of 200,000 hours on average
- ✓ Low cost and plug and play solution





KANT: PIPELINES AND WELLS MONITORING

Where we are now



Disadvantages:

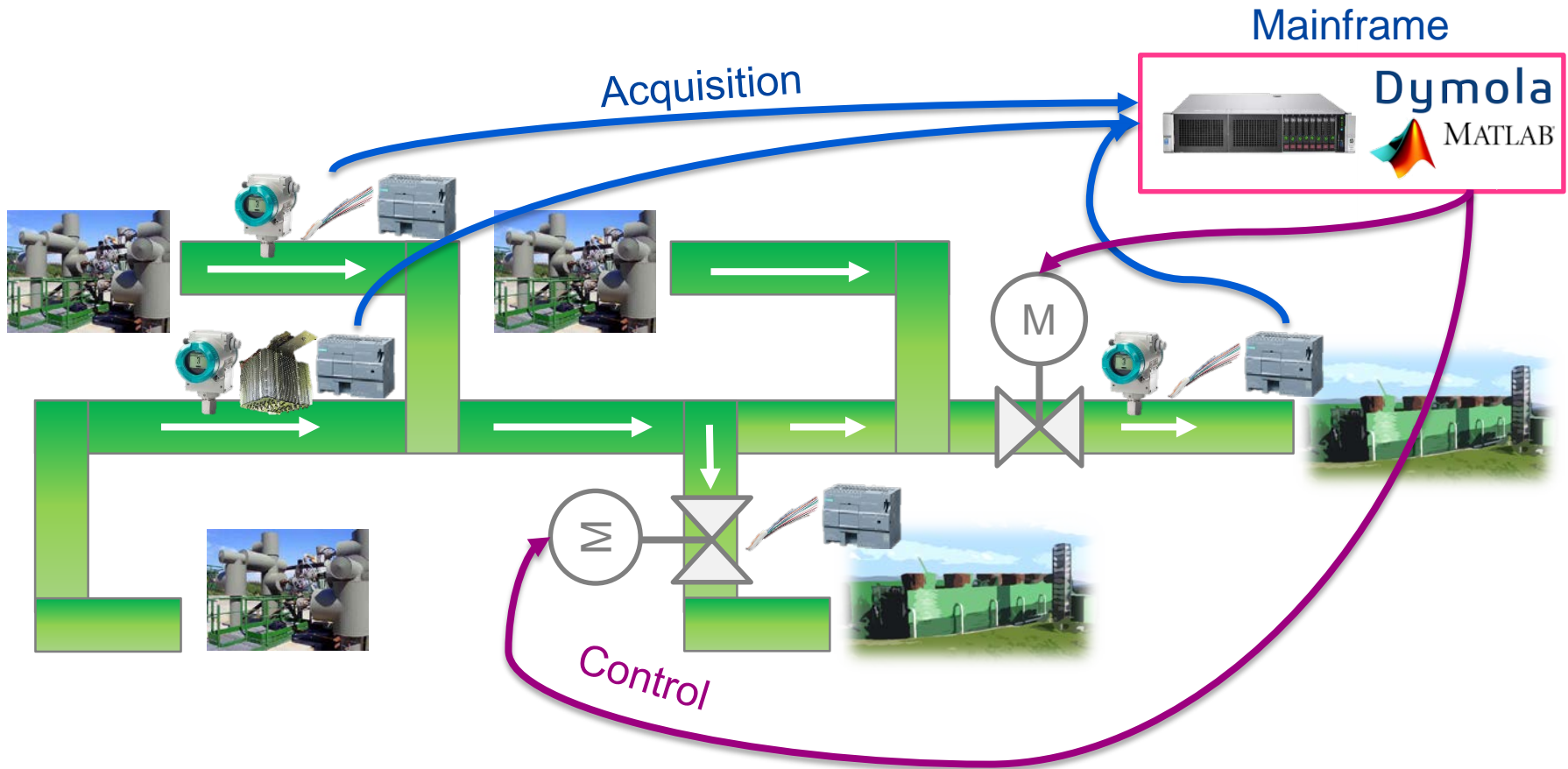
- Spot monitoring of the network
- Monitoring of flows only on washed wells and plants
 - Manual valves on the pipes





KANT: PIPELINES AND WELLS MONITORING

Where we will be



Advantages:

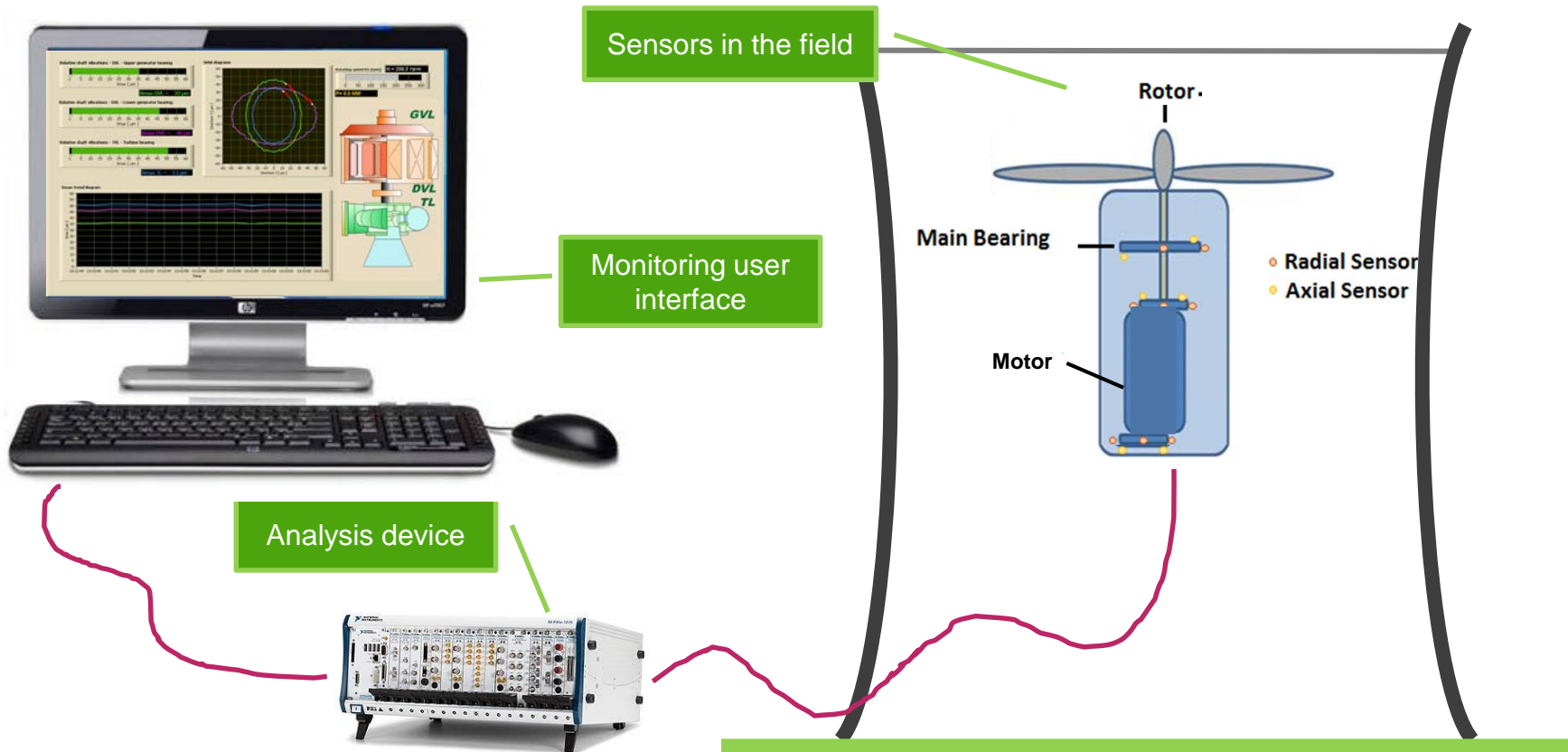
- ✓ Monitoring of steam network flows in real time
- ✓ Diagnosis of the steam network status
 - ✓ Optimization of steam distribution
- ✓ Environmental protection and diagnostics on possible breakages





KANT: AUXILIARIES MONITORING

Water pump and cooling tower vibration analysis



Advantages:

- ✓ Increase of auxiliaries monitoring
- ✓ Preventive maintenance interventions on auxiliaries components





DIANA: SOFT REALTIME ALGORITHMS

From the sensors to the power plant analysis

Sensors validation



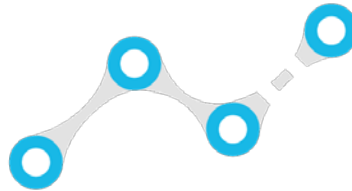
Technology used:

- Correlation
- Chi Quadro test

Advantages:

- ✓ Robust data calculation
- ✓ Detect sensors fault

Signals prediction



Technology used:

- VAR, ARIMA stochastic process

Advantages:

- ✓ Avoid future alarms verification
- ✓ Avoid production lost

Power plant subsystem prognosis



Technology used:

- Machine learning
- Neural networks

Advantages:

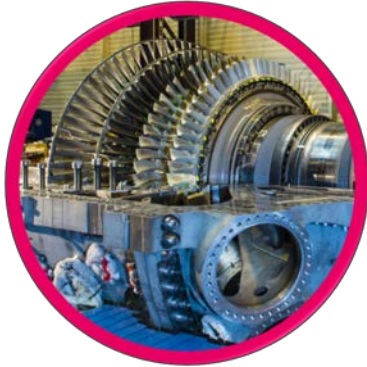
- ✓ Avoid efficiency loss
- ✓ Recognize the specific event happened





DIANA: HARD REALTIME ALGORITHMS to optimize process control

GAS COMPRESSOR CONTROL



Technology used:

- **Pattern recognition** for surge events
- **Compressor curve** for comparing the real time data with the curve
- **Adaptive control** for opening/closing anti-surge valves
- **Machine learning** for updating the compressor curve and the surge dictionary

Advantages:

- ✓ Avoid surge events
- ✓ Avoid production losses
- ✓ Increase the power production

STEAM PH CONTROL



Technology used:

- **Process delay identification** from the pump to the measure of PH
- **Transfer function identification** from the pump command to the PH value
 - **Adaptive control** for regulating the pump

Advantages:

- ✓ Optimize soda consumption
- ✓ Reduce pipelines corrosion

