

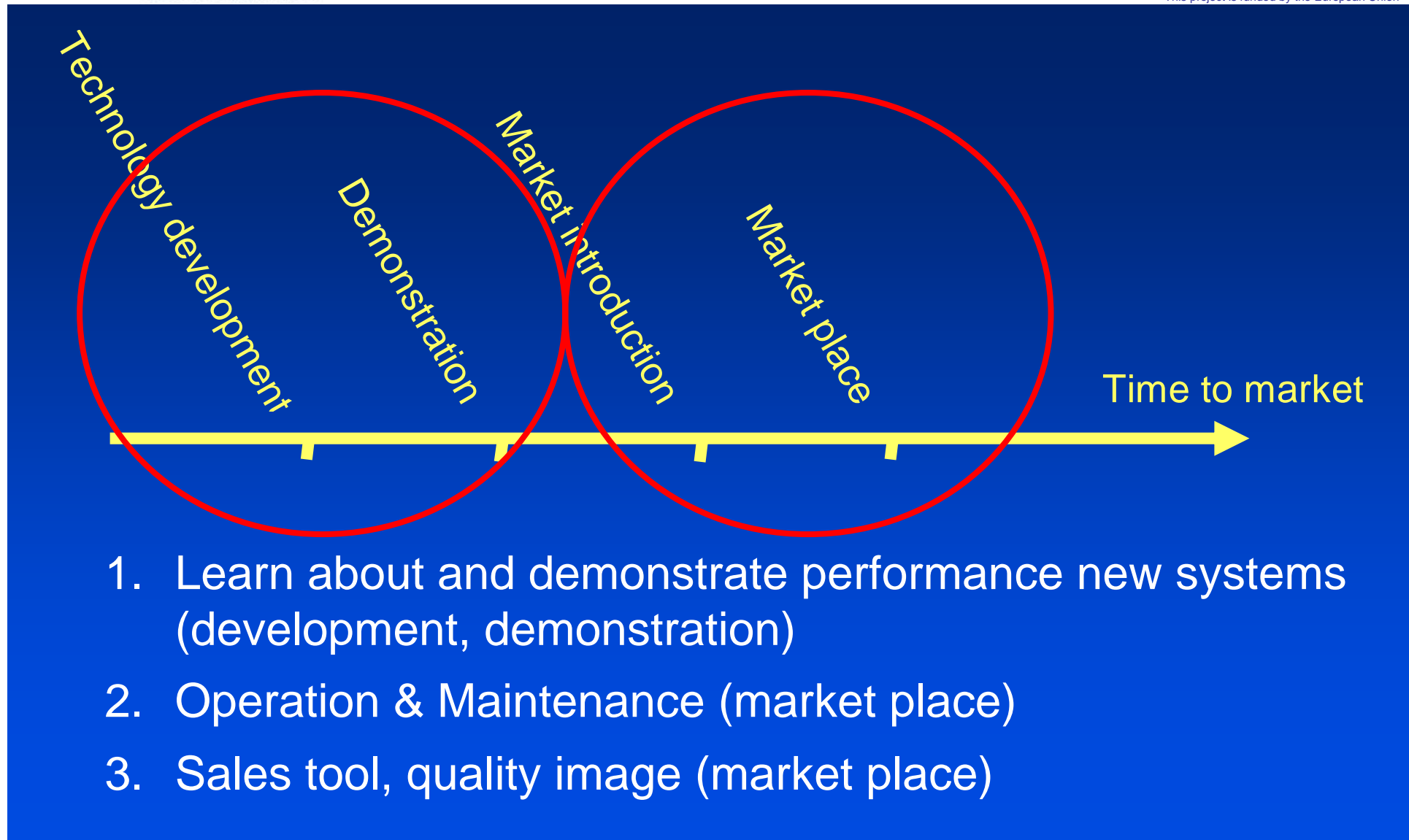
Monitoring of pilot projects



F. Zegers, Ecofys, Netherlands

- What is monitoring?
 - To follow certain processes / parameters in time
 - To interpret and draw conclusions from the data

Why monitoring?



1. Learn about and demonstrate performance new systems (development, demonstration)
2. Operation & Maintenance (market place)
3. Sales tool, quality image (market place)

- Development of monitoring concept
 - Performance indicators
 - Reference
 - Parameters that can be measured / calculated
 - Flow diagram: provide a clear insight in our monitoring concept
- Selection of measurement equipment
- Installation of measurement equipment
- Testing of measurement equipment
- Monitoring procedures (who, what, when)
- Execution monitoring
- Reporting

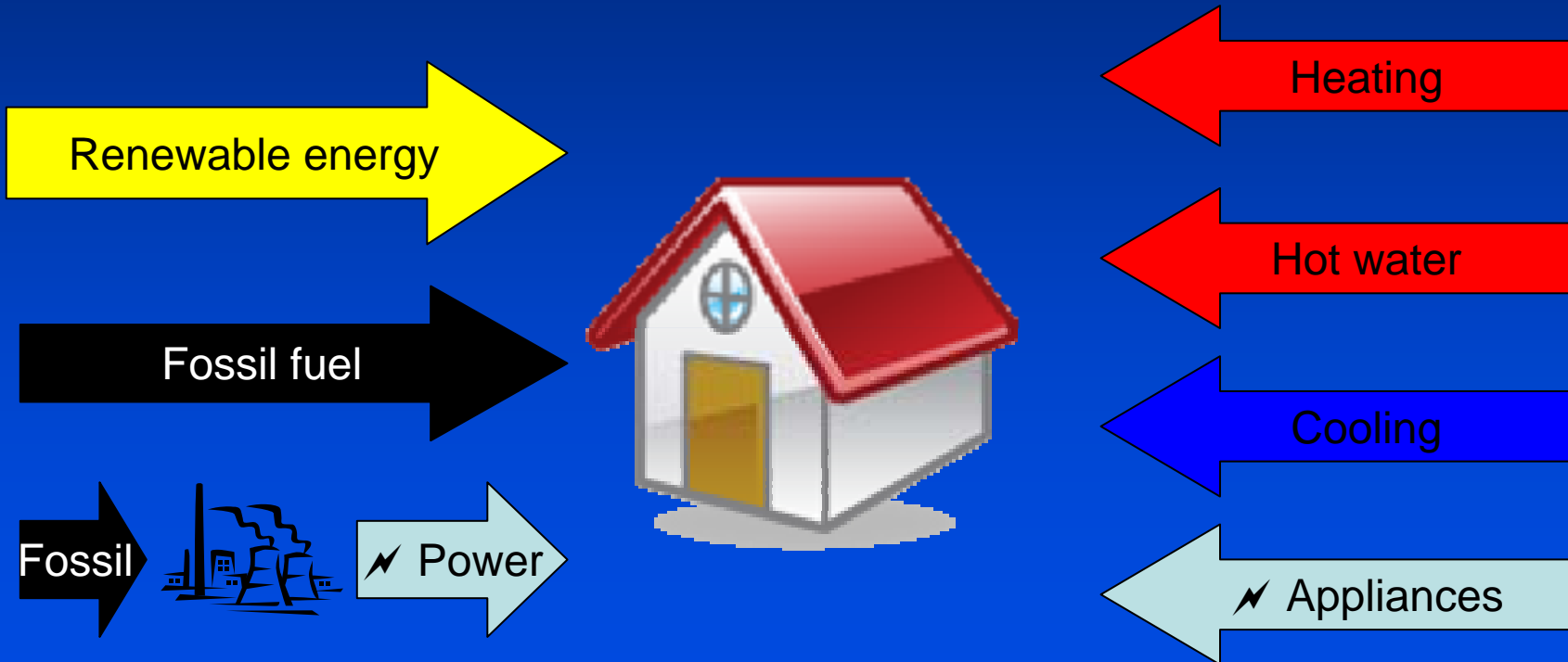
Energy sources

- Oil, gas
- Sun, ambient heat

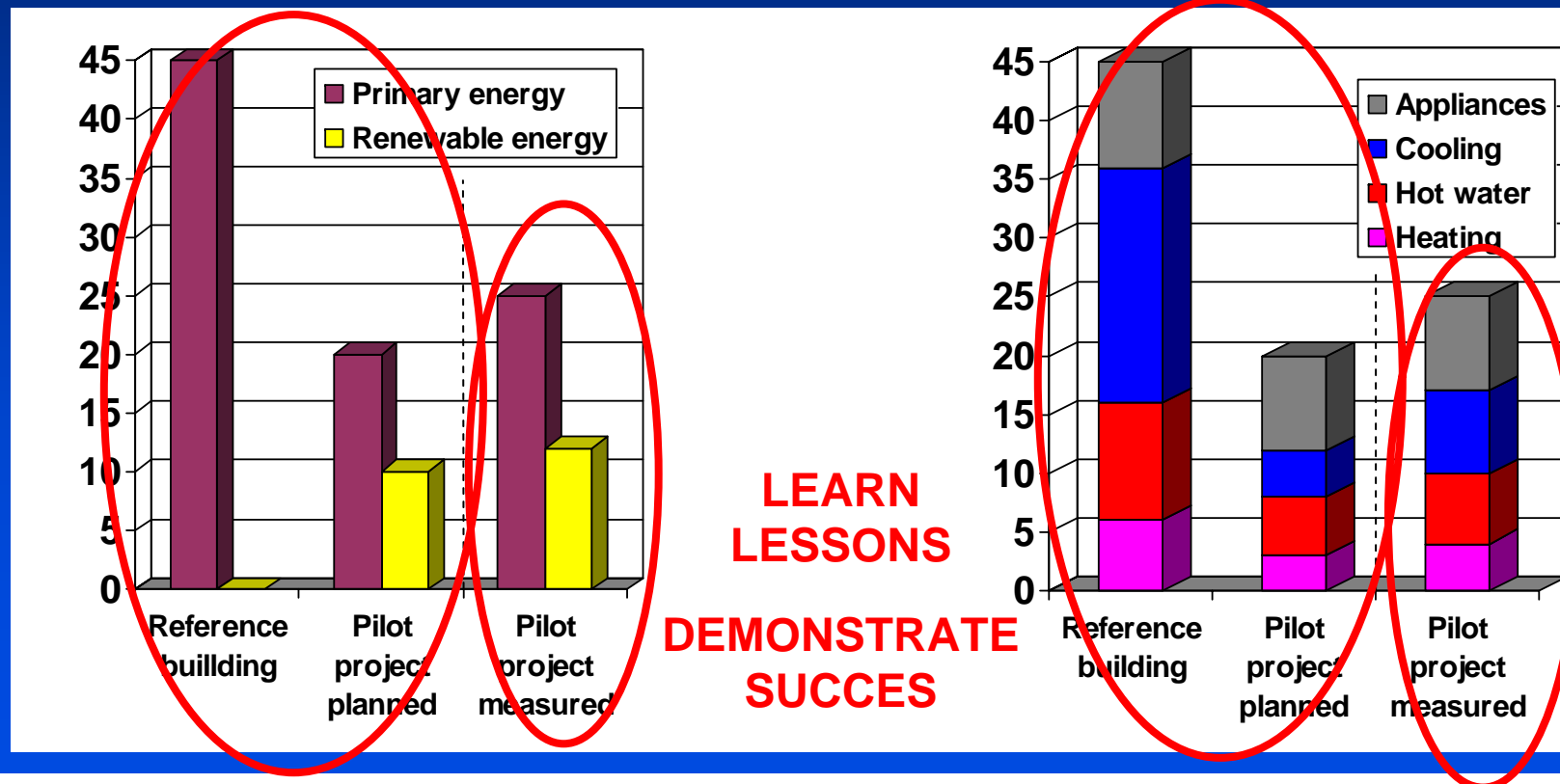
Your pilot project

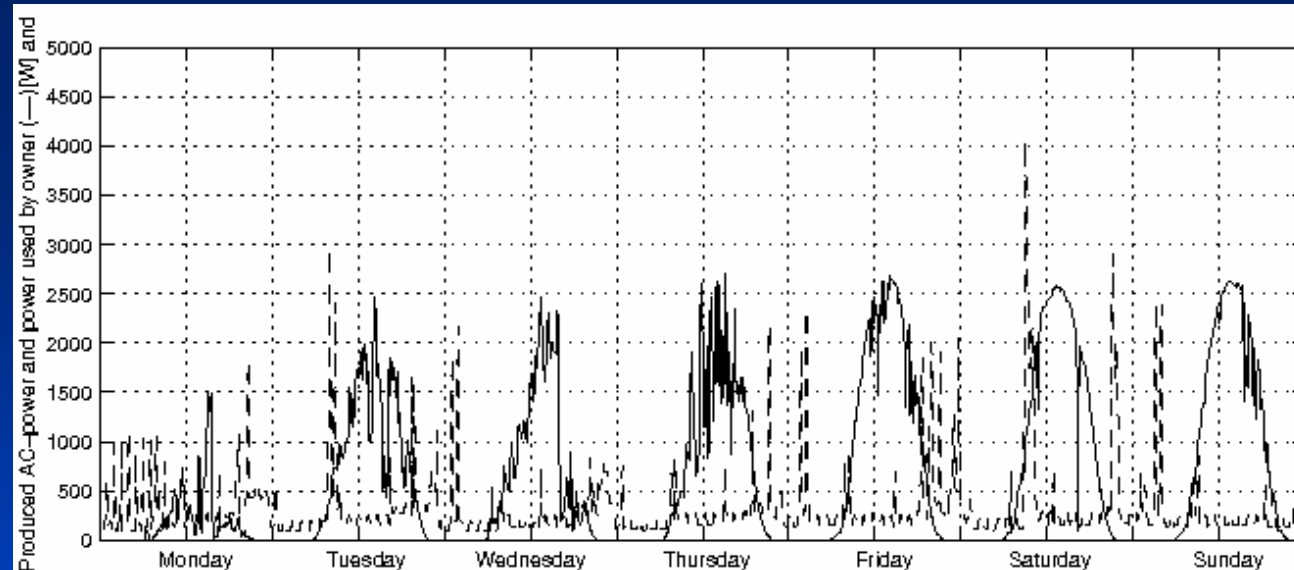
- Renewable energy system
- Energy efficiency

Energy services



- How do we know if we reached our goals?
- Reference / base line energy consumption for similar building with conventional solutions



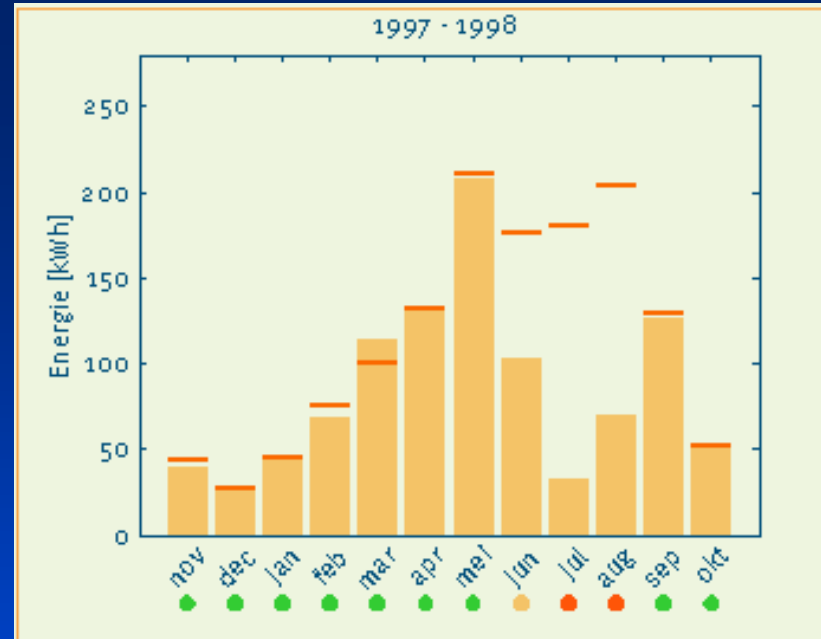


- Time dependant parameters
- Automated data storage with short time steps
- Detailed performance analysis
- Optimising control strategies
- Requirements:
 - Data logger
 - Electronic sensors
 - Pulse outputs on energy / electricity meters

**Temperature measurement
in pipe with zero flow:**

No relevance !

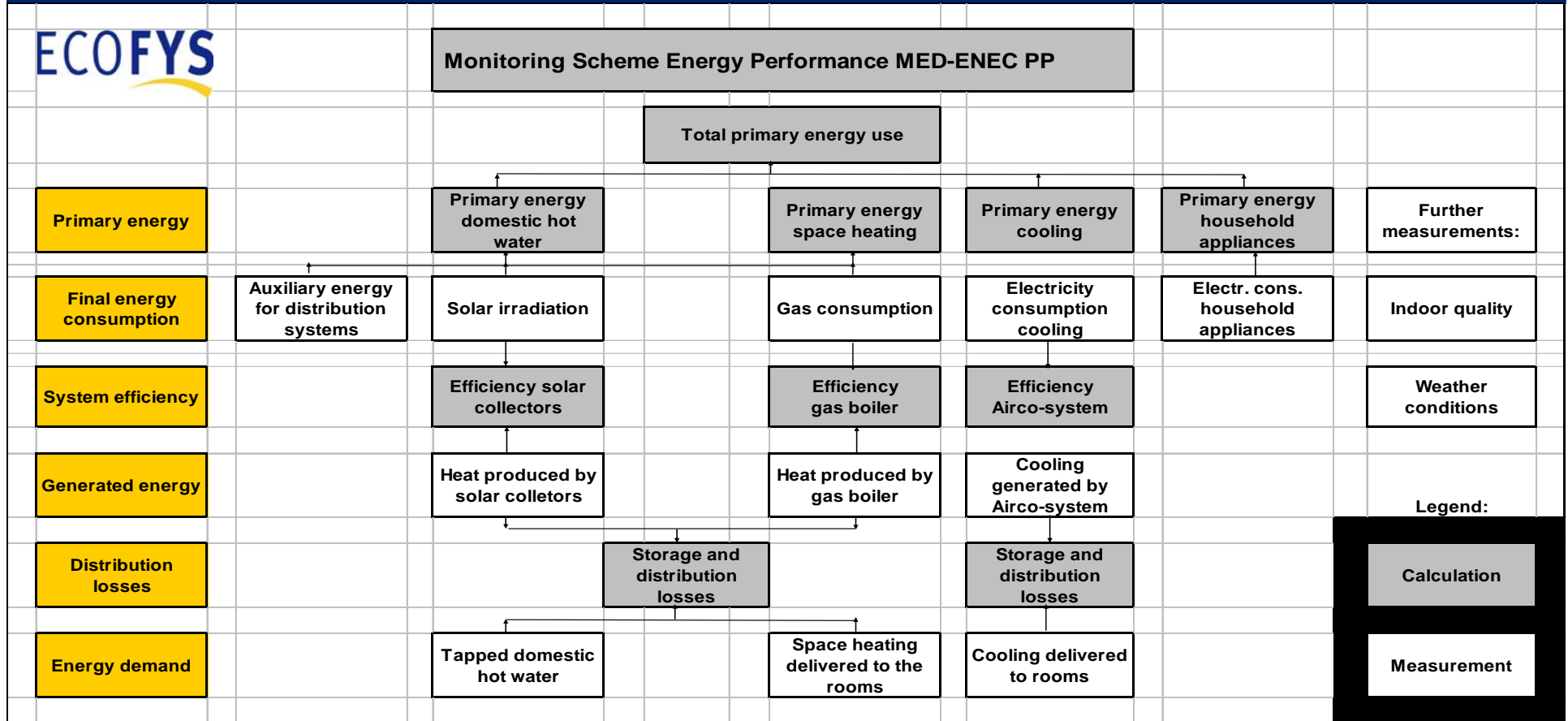
**Flow weighed average
temperature**



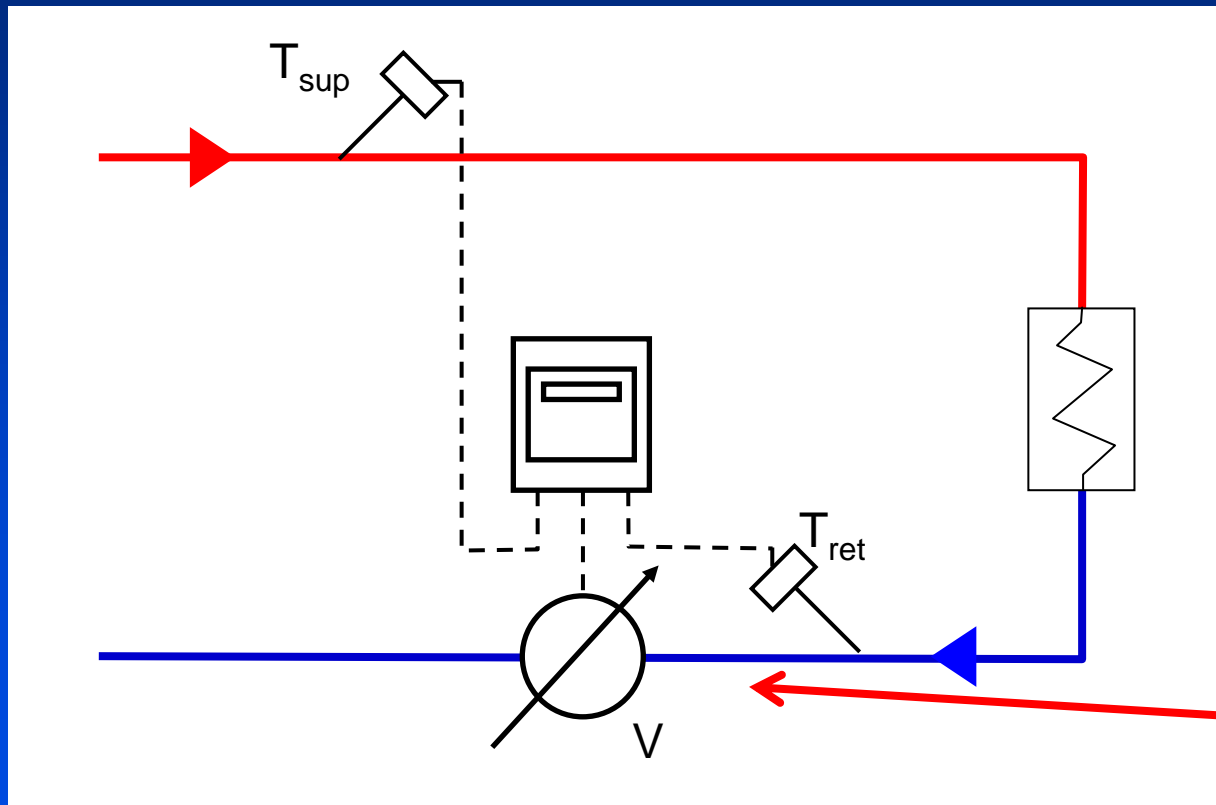
- Manual meter readings (weekly, monthly)
- Also for less time dependant parameters (combined with analytical monitoring)
- Overall analysis system performance and efficiency
- Requirements:
 - Sensors / meters that can be read manually
 - Acquisition of actual meteorological data from national meteo station

- Gas total gas consumption
- Oil total oil consumption
- Electricity total, cooling, heating, appliances
- Heat / cold flows hot water, heating, cooling, solar
- Fluid flows hot water
- Temperatures outdoor, indoor, fluid flows
- Solar irradiation global, direct, diffuse, tilted
- Humidity

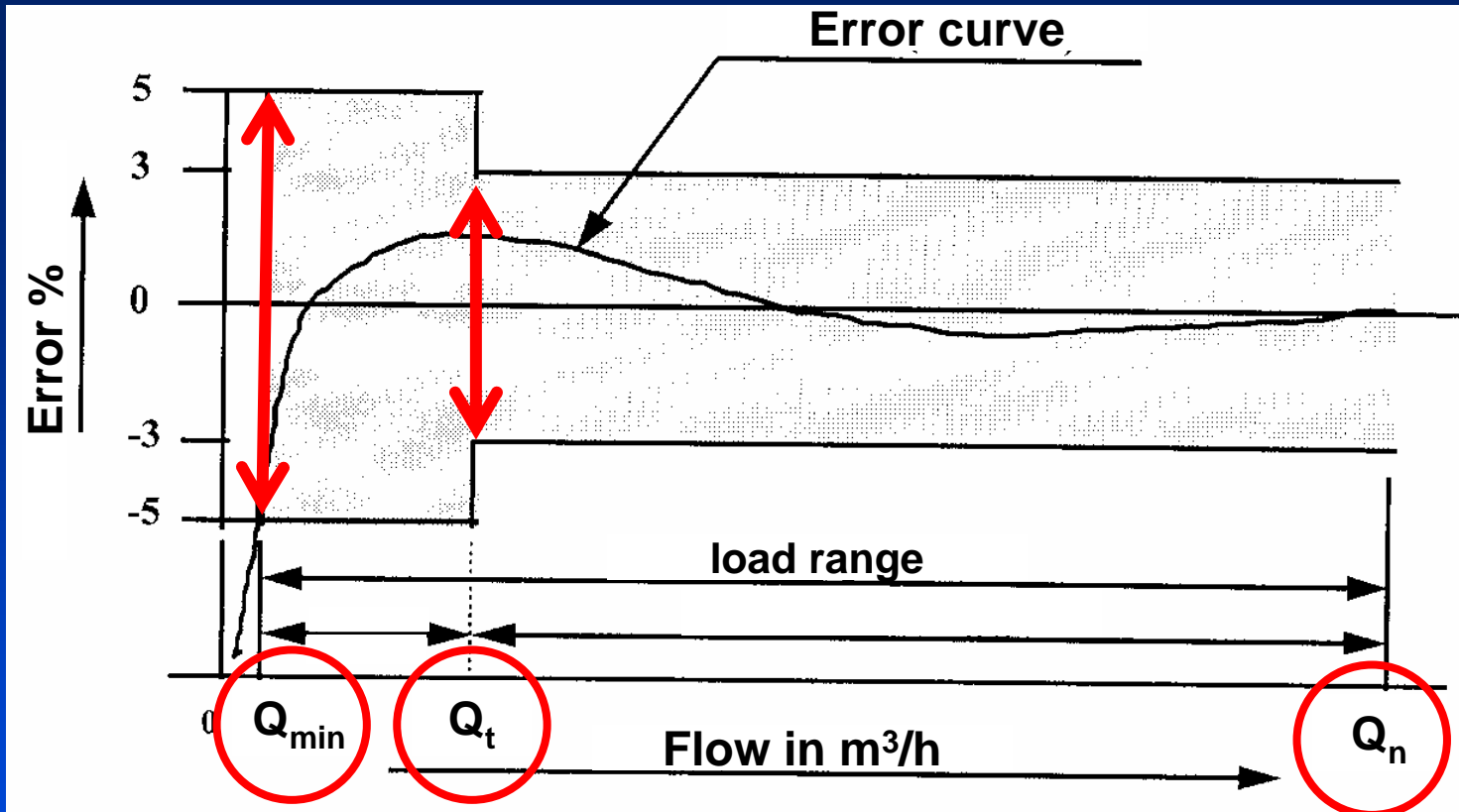
- System efficiencies heat pump, solar system
- Spec. energy consump. heat and cold demand / m²
- Energy savings total, heating/cooling, hot water
- Assumptions / conversion factors m³ gas to kWh
primary energy factor electricity



$$\text{Heat / cold} = V \times (T_{\text{hot}} - T_{\text{cold}}) * C_p$$



**Flow meter in return !
Cp with Tret used**

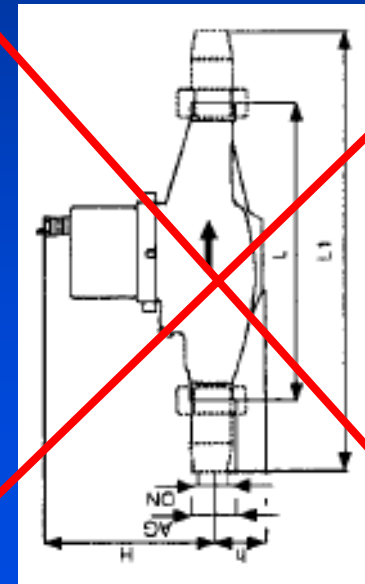
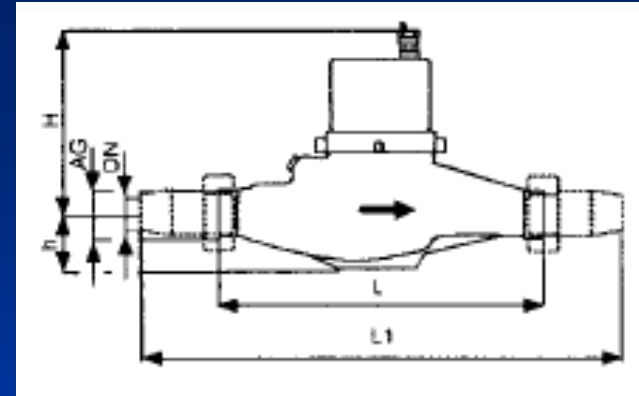
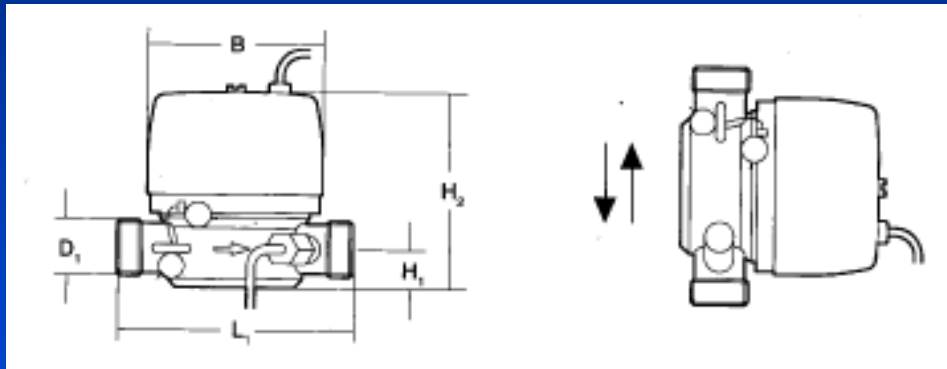


Q_n = nominal flow, for long term loads

Q_t = transition flow, $Q > Q_t$, error $< 3\%$

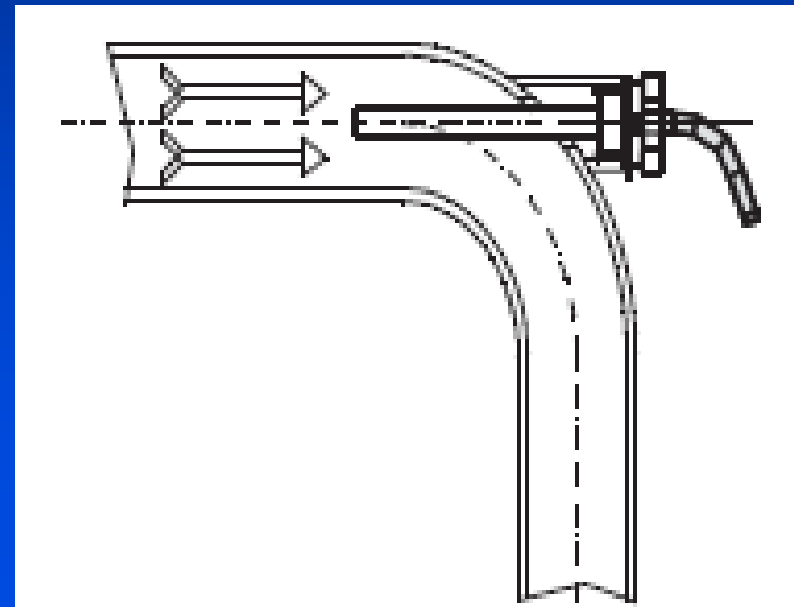
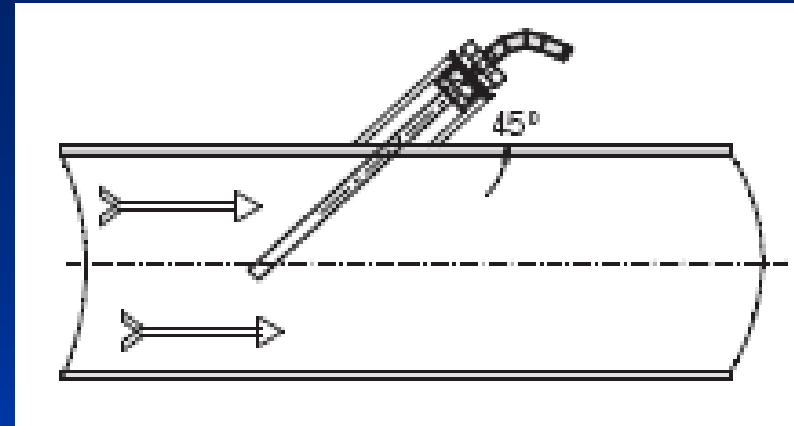
Q_{min} = minimum flow, $Q > Q_{min}$, error $< 5\%$

- Flow meter
- Correct mounting

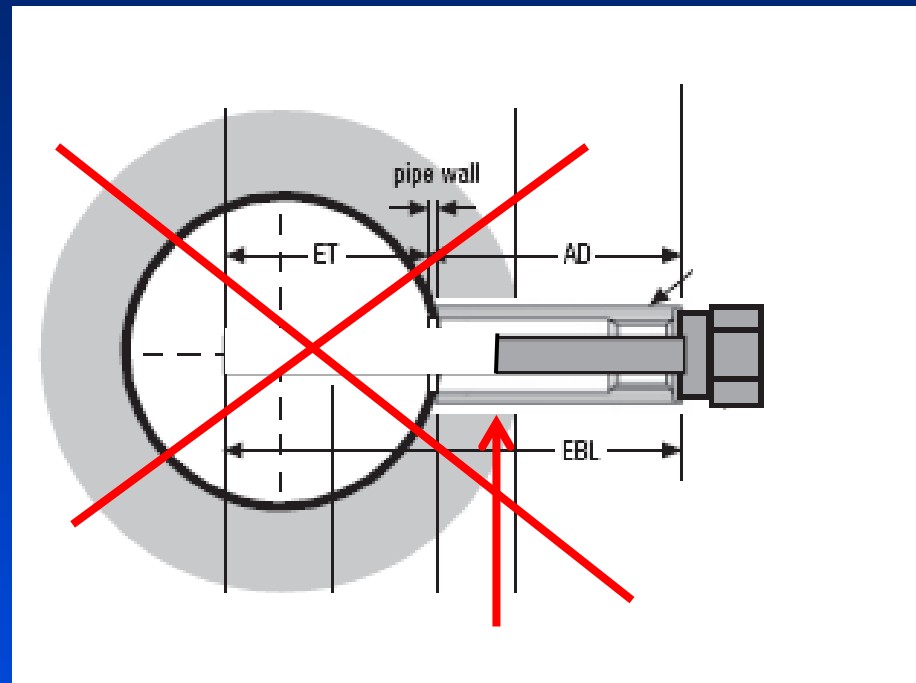


- Mostly in 'cold' return pipe
- Hot pipes: temperature resistant

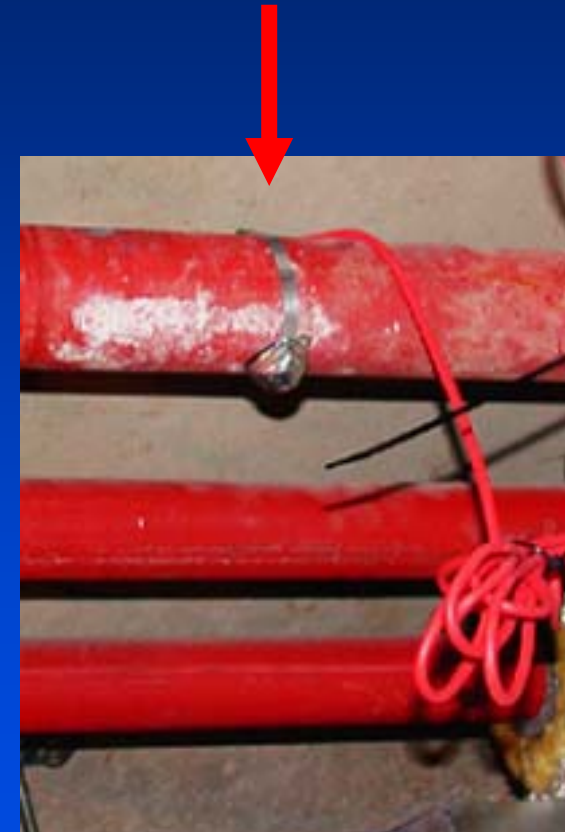
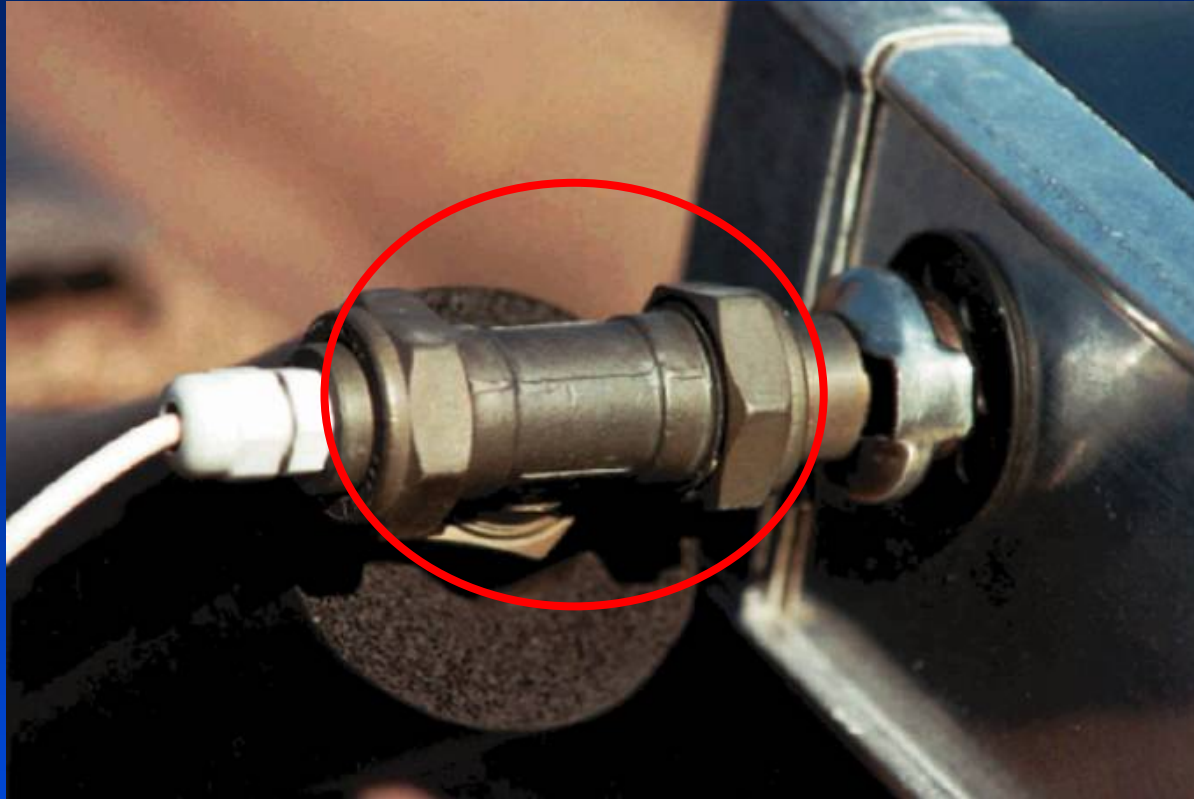
Temperature



- Temperature sensor fully immersed



- Temperature sensors come in pairs
- Always use pairs (do not mix hot / cold sensor)
- Paired sensor cable extensions: equal lengths !



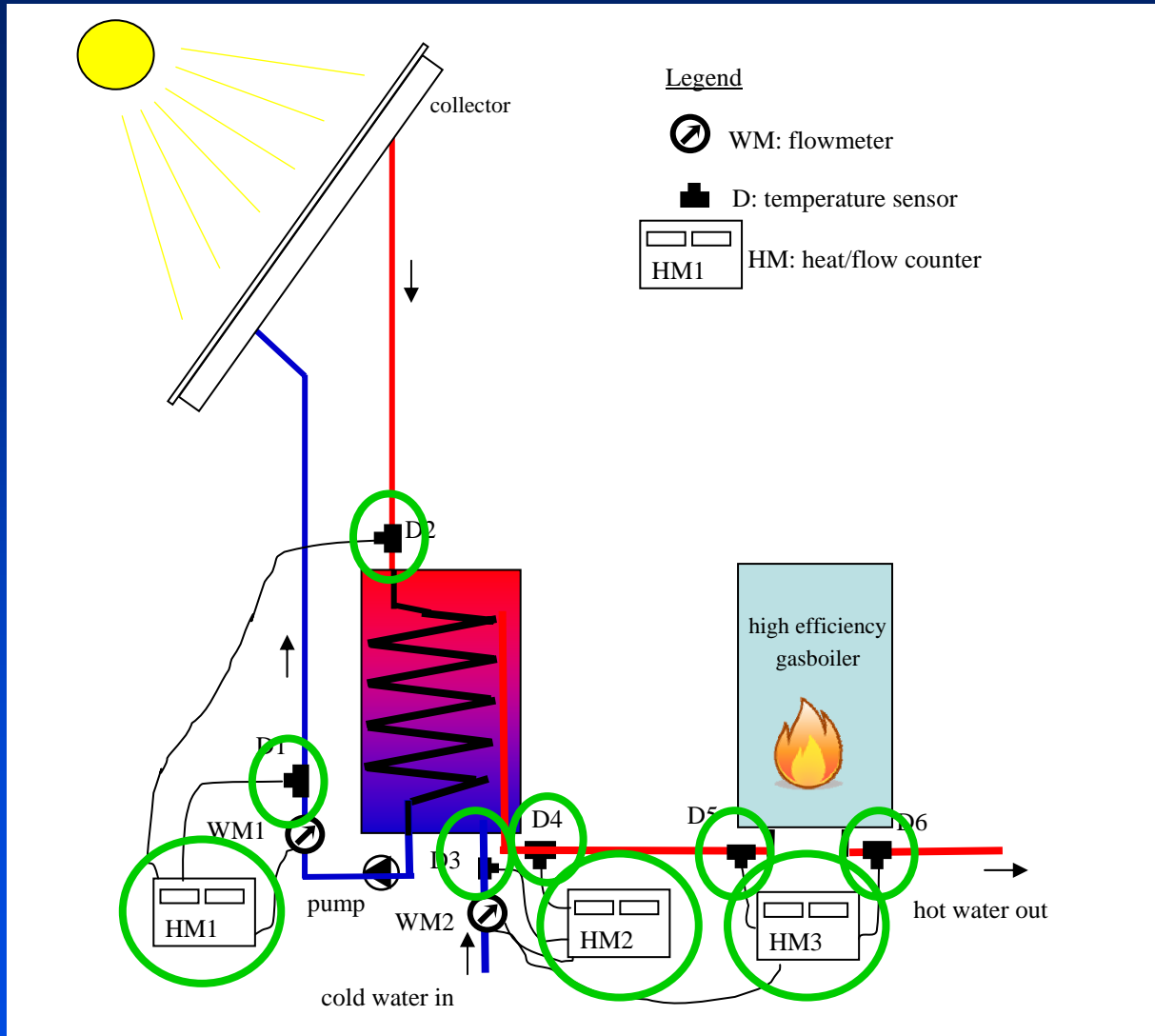
Heat insulation?

Sensor length?



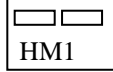
An example



This project is funded by the European Union



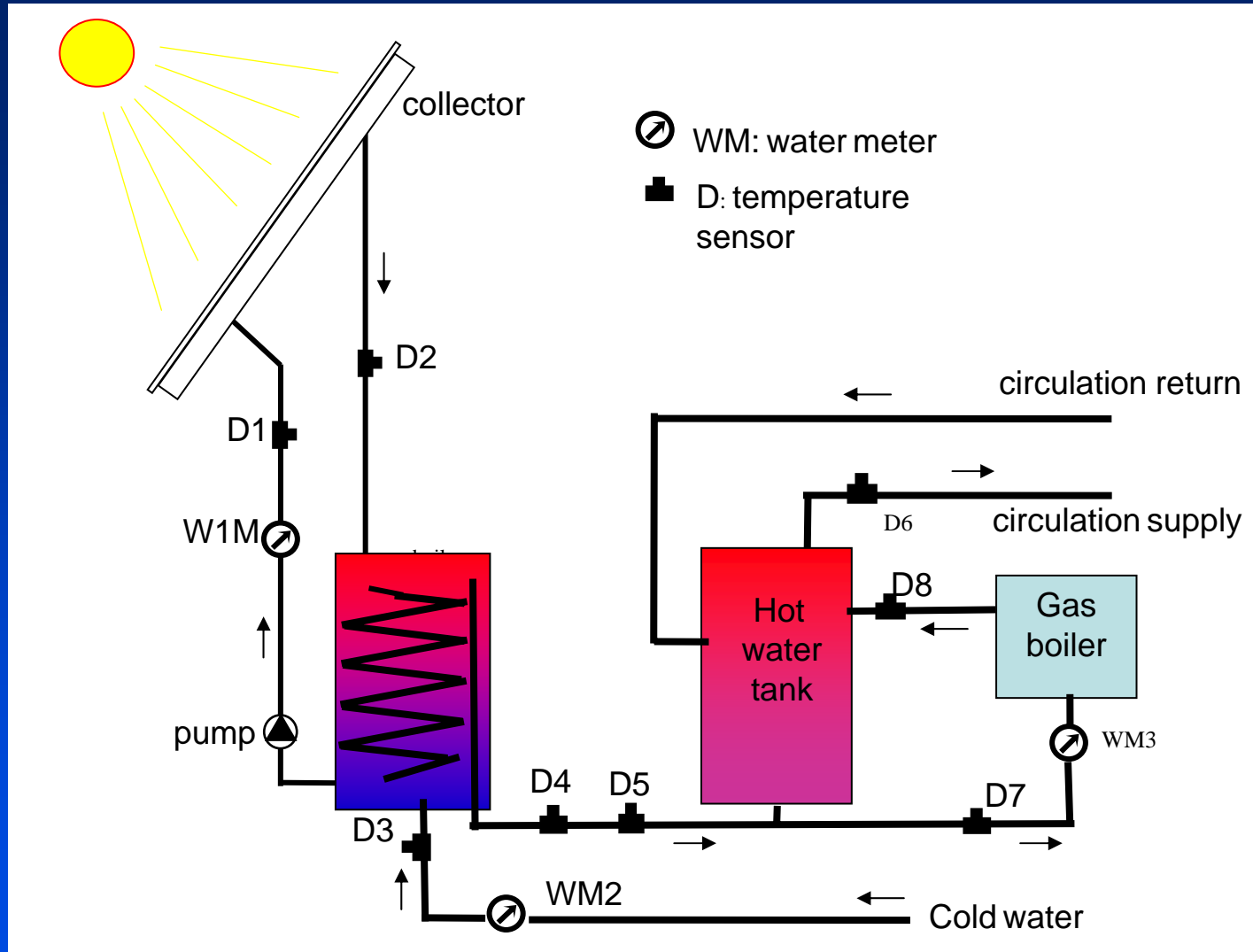
Legend

-  WM: flowmeter
-  D: temperature sensor
-  HM: heat/flow counter

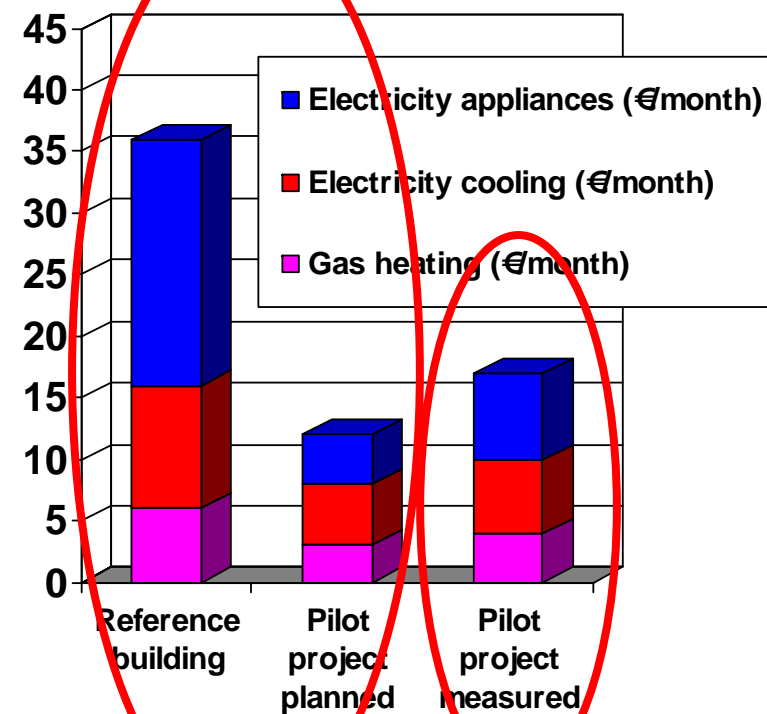
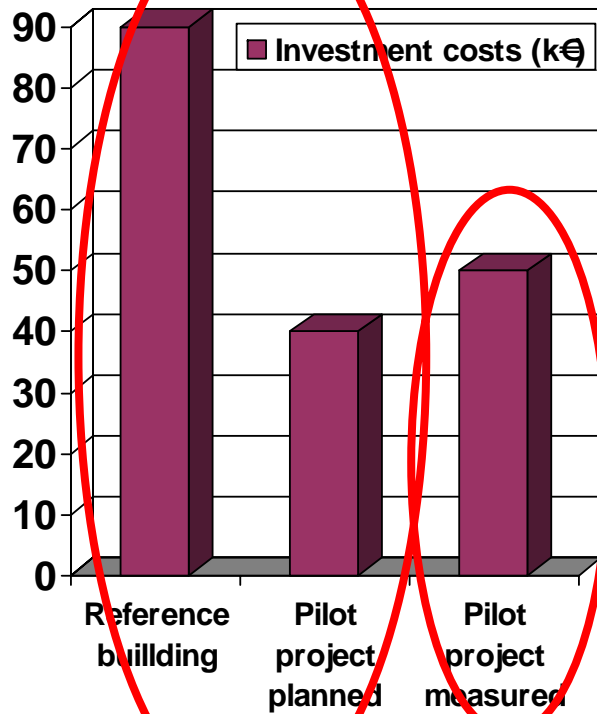
Another example



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- Indicators for economic performance
 - Investment cost (total and additional)
 - Annual energy cost (total and per energy carrier)
 - Other operational costs (e.g. maintenance)
 - Pay back time (sensitivity analysis for energy prices)
- All cost in Euro (total, per m², indicate exchange rate)
- Definition of reference and planned economic performance
- Distinguish:
 - Total project cost effectiveness compared to reference
 - Cost effectiveness for replicable measures (excluding high cost R&D measures)



Monitoring energy and economic performance:

- Development of a sound monitoring concept
 - Performance indicators, reference (conventional, planned performance)
 - Proper hardware (selection, installation, testing)
 - Proper procedures for execution and reporting (who, what, when)
- Key factor for:
 - Learning potential, improving energy concepts
 - Replication, market introduction

- Med-Enec monitoring guidelines
- International Performance Measurement & Verification Protocol

