



FROM IDEA TO EXECUTION

Guideline and obstacles for successful heat pump implementation

Michael Pölzl, Austrian Institute of Technology

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AGENDA

- Obstacles and Incentives for Heat pump-assisted drying
 - Dryer Operator
 - Dryer Manufacturer
 - Heat Pump Manufacturer
- Procedure guide: Step-by-step guide to heat pump implementation

DRYER OPERATOR



Obstacles & Incentives to Adoption

Obstacles



Economics

High CAPEX, volatile energy prices, long payback, low-margin business, new safety requirements



Technical Risk

Start-up challenges, lower-than-designed performance, unexpected maintenance



Knowledge & Integration

Limited HP expertise, retrofit complexity, space restrictions, more suppliers involved

Incentives

Green product demand & CO₂ regulation / trading

Policy incentives

Public financing & demonstration project support

“Off the shelf”-solution reduces complexity

New dryer → greenfield design opportunity

Design tools & software to support decision-making

The business case exists - operators need proven references and reduced complexity to act.

DRYER MANUFACTURER



Obstacles & Incentives to Adoption

Obstacles



Knowledge Gap

Expert in drying, not in heat pumps. Limited cross-domain know-how and lack of public information.



Design Conflict

Bigger dryer needed for lower COP — cost pressure pushes customers toward cheaper alternatives.



Development Cost

High upfront R&D costs. Space constraints. Limited demonstration opportunities

Incentives

End-user demand for green & sustainable products

Long-term contracts change economics

Large customer contracts justify development investment

Direct link to HP manufacturers

Positive dryer performance impact with right integration

Cross-industry knowledge transfer and shared R&D risk are essential.

HEAT PUMP MANUFACTURER

Obstacles & Incentives to Adoption



Obstacles



Process Know-How

Limited knowledge of drying requirements.
Unstable heat source/sink from discontinuous
dryer operation.



Technical Limits

High temperatures. Often requires HP +
steam compression.



Market Risk

Reputation risk in high-risk novel application.
Two-company integration adds coordination
complexity.

Incentives

New partnerships & collaboration with dryer manufacturers

Large market potential - serial production once established

Detailed SSD process overview enables tailored HP design

Reference projects / use cases unlock further market entry

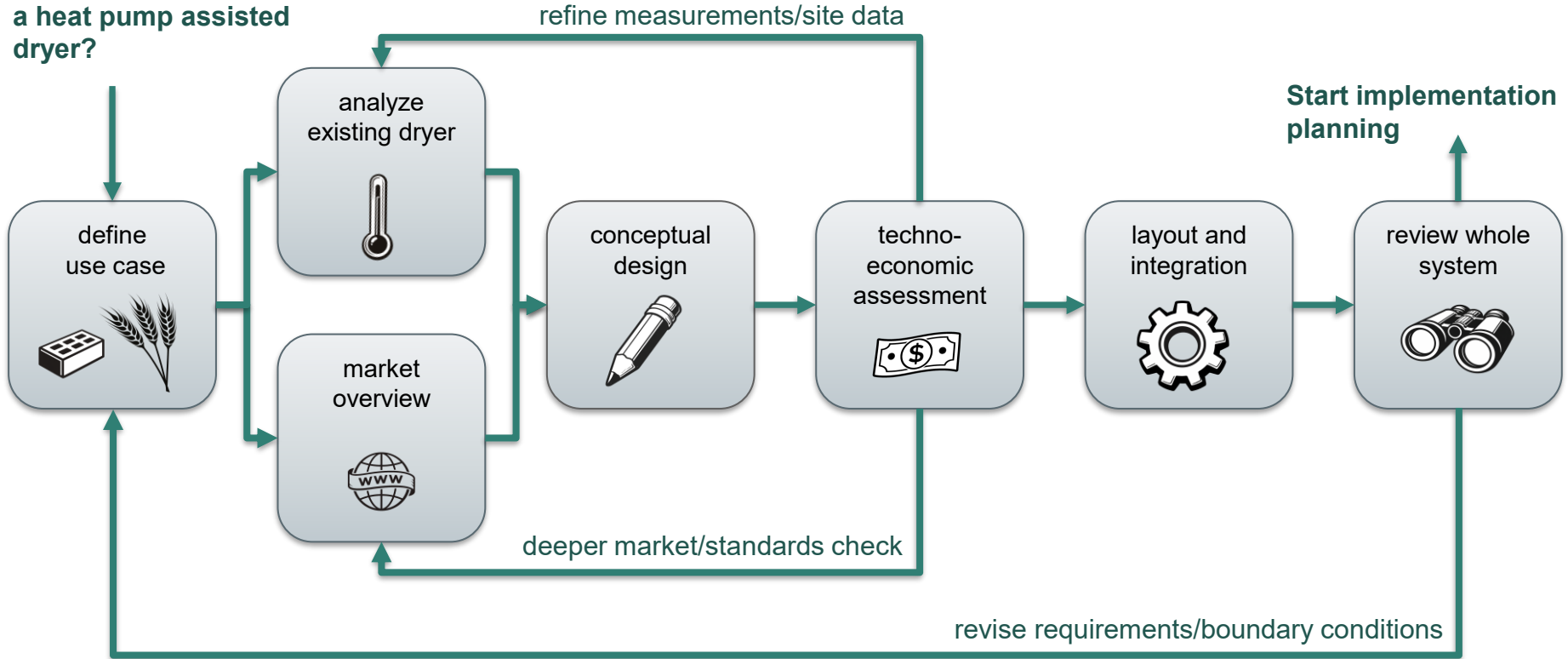
Process integration know-how is the entry ticket to the market.

PROCEDURE GUIDE

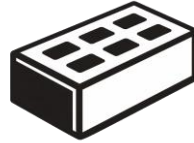
Step-by-step guide to heat pump implementation



Intention to implement a heat pump assisted dryer?



DEFINE USE CASE



- Clarify process & product needs
- Application: food, biomass, wood, textile, etc.
- Dryer requirements: input/output quality, flows, allowed product temperature, space
- Batch vs. continuous
- Production quantities (now & future)
- Target product quality, drying conditions, moisture content



- Mujumdar Arun S.:
"Handbook of Industrial Drying"
- Minea V.:
"Advances in heat pump-assisted drying technology"



ANALYZE EXISTING DRYER

- Perform measurements (temperature, humidity, flows, energy)
- Identify main losses of current dryer
- Determine local conditions: space, electricity, money
- Analyze summer and winter conditions
- Assess direct heat recovery potential and integration with other processes
- Insulation & reuse of heat, link to cooling demands
- Check other high temperature sources: geothermal, waste heat, distillation, etc.



- Pinch analysis could help

MARKET OVERVIEW



- Market overview for dryers & heat pumps
- Talk to suppliers: heat pumps, heat exchangers, electric heaters
- Discuss with manufacturers with experience
- Expert interviews
- Internal knowledge sharing / workshops



heatpumpingtechnologies.org

- project 58
- project 59
- project 68

Großwärmepumpenportal

CONCEPTUAL DESIGN



- Rough calculations: COP, electricity use, capacity, Carnot efficiency
- Dryer: temperature profile, length, residence time
- Trade-offs: temperature vs. time, throughput vs. efficiency
- Consider air flow & HEX design (circulation rate, dehumidification)
- Make sure: heat sink temperature for latent heat recovery is low enough
- Consider operation vs. electricity price (storage/buffers)
- Document assumed efficiencies



Drying Toolbox
<https://drying-toolbox.ait.ac.at/>

TECHNO-ECONOMIC ASSESSMENT



- Compare and select heat pump configuration
 - closed/open loop
 - transcritical
 - cascade, stages
- Size heat pump
 - capacity and power
 - number of units
- Evaluate COP & seasonal performance
- Compare energy use & operating cost vs. baseline dryer
- Evaluate throughput vs. efficiency for chosen concept
- Sensitivity to assumed efficiencies & climate (summer/winter)

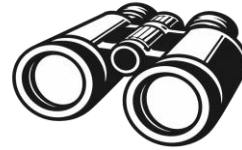




LAYOUT AND INTEGRATION

- Define auxiliary equipment (fans, pumps, valves, condensate)
- Check space, structural limits, entry ways & gates
- Size, sound, fire safety, vibrations, ventilation
- ATEX, pressure vessel, CE compliance
- Maintenance: space, access, spare parts
- Measurements and monitoring
- Control system integration (dryer & heat pump, temperature & humidity control)
- Condensed water treatment
- Redundancies / backup heating
- Sustainability: low-GWP refrigerant, recyclable materials

REVIEW WHOLE SYSTEM

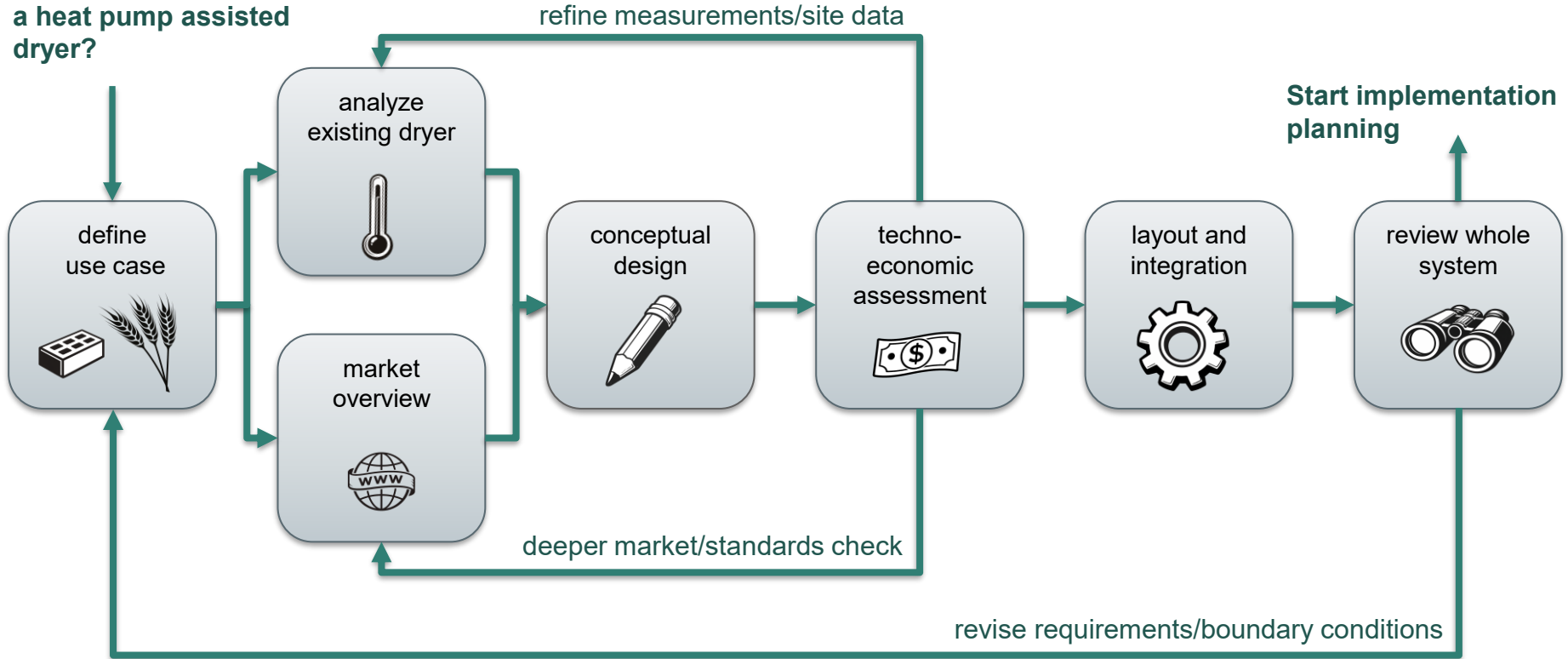


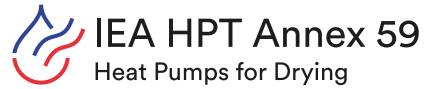
- Check the fit with long-term site strategy & energy system
- Re-check production growth & product quality targets
- Review safety, regulatory & sustainability goals
- Compare candidate concepts & select preferred option
- Timeschedule
- Define Go / No-Go criteria



Think of delivery times and
shutdown windows

Intention to implement a heat pump assisted dryer?





THANK YOU!

Michael Pölzl

michael.poelzl@ait.ac.at

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