IKI SOLARPAYBACK
TRAINING ON SOLAR PROCESS HEAT IN SOUTH AFRICA

Feasibility Procedures

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www.ise.fraunhofer.de

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Content

- Pre-feasibility procedures
- Feasibility procedures
- Required Data
- In-situ measurements
- Examples

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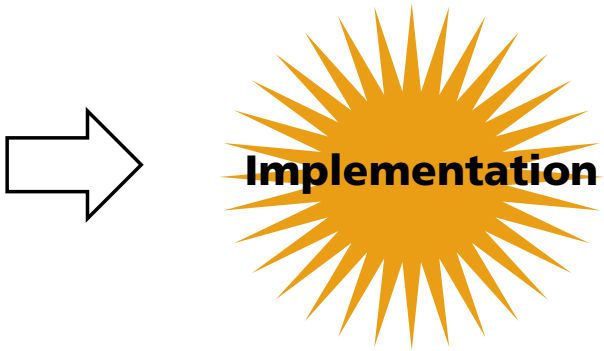
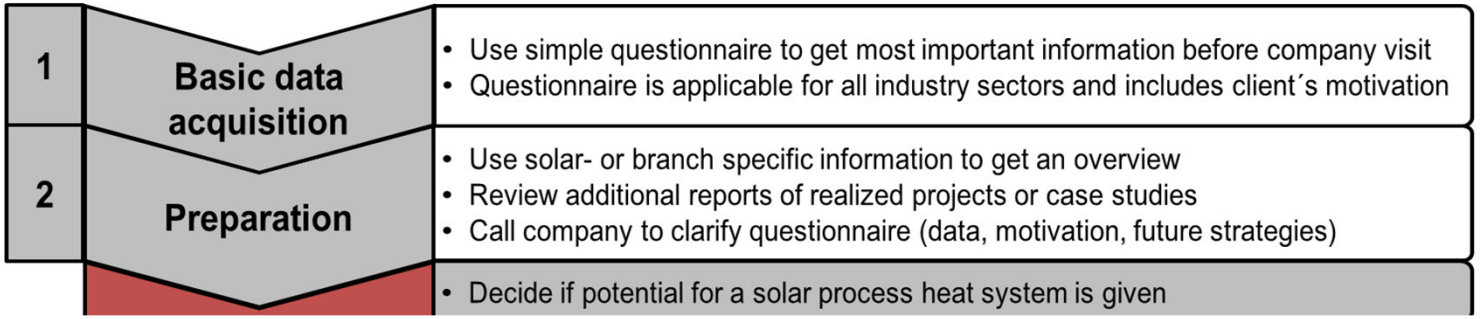
Prefeasibility and Feasibility Procedures
General procedure

- Definition of solar process heat potential
  - Pre-evaluation
- Identification of possible integration points
  - Technical analysis
  - Economic analysis
- Recommendation for solar integration



Prefeasibility and Feasibility Procedures
Pre-feasibility assessment

- Steps 1-2
  - Potential for solar process heat



[1]

[1] www.solar-process-heat.eu/checklist

Content

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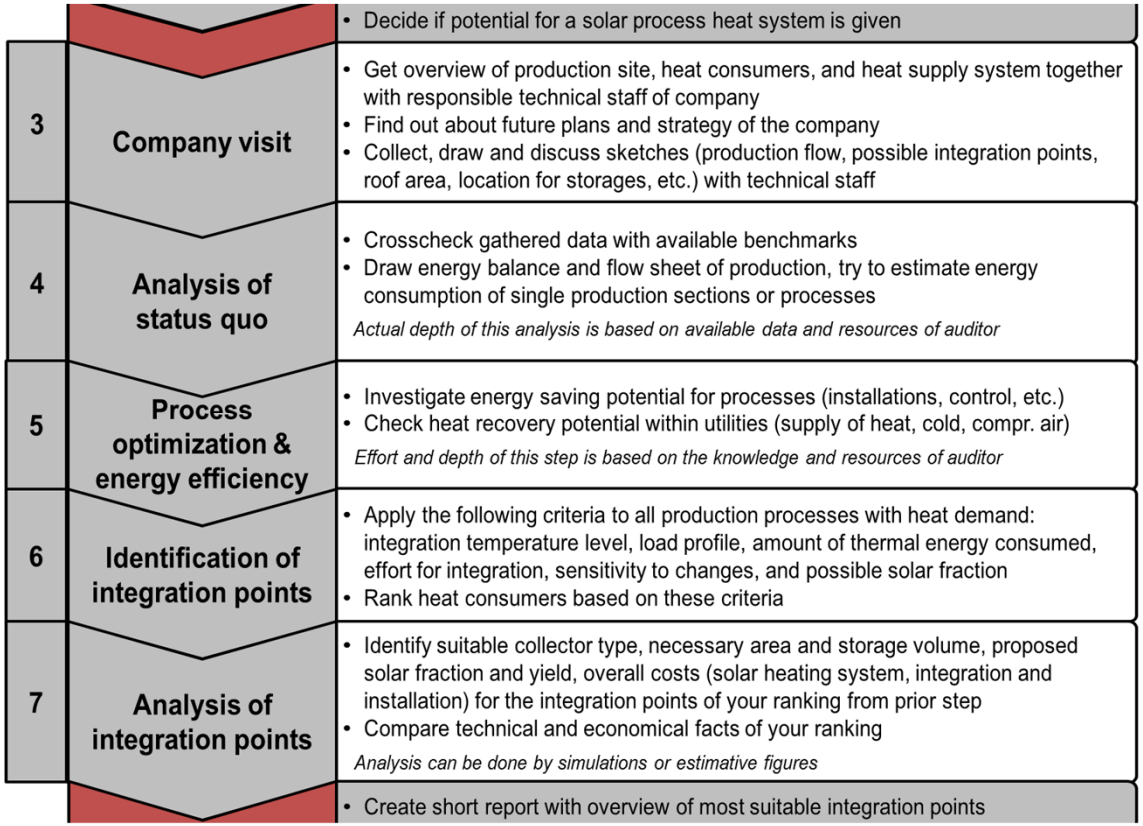
Prefeasibility and Feasibility Procedures
Feasibility Study

- Steps 3-7
  - Define possible integration points

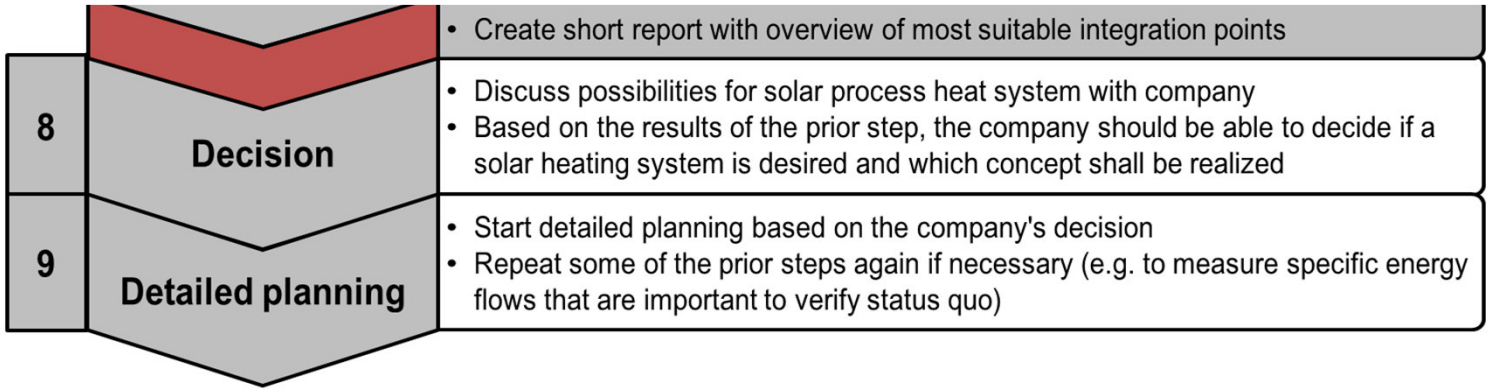


[1]

[1] www.solar-process-heat.eu/checklist

Prefeasibility and Feasibility Procedures
Conclusion

- Steps 8-9
  - Decision and detailed planning



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Required Data
General Information

- Basic company information
  - Location
  - Branch
  - Products
  - Annual Production
  - Operation period
  - Main heating/cooling requirements
  - Main processes
  - Nr. employees

1
Basic Company Information

The beverage company [redacted] is situated [redacted] with approximately [redacted] employees. At this site, juices and nectars are produced out of fresh fruits. The production is running 24 hours a day (three shifts of eight hours), seven days a week, 332 days a year.

Main heat requirements of the company arise in the heating and cooling of processed beverages. Two gas driven steam boilers are producing slightly superheated steam, which is led to different heat exchangers. When the steam condenses inside the heat exchangers, heat is transferred to a hot water loop. By another heat exchanger, the hot water heats up the beverages in order to pasteurize the product. The heated product stream is subsequently cooled down in a cold water-to-beverage heat exchanger. The cold water with a temperature of 9°C is provided by different chillers with screw compressors. Another cold consuming process is the internal production of plastic bottles. The produced bottles are cooled down with a cold water stream. The heat sink of this process is generated by the already mentioned chillers as well.

Therefore, the company has three main production lines:

- Production of plastic bottles
- Process [redacted]
- Process [redacted]

No details concerning installed efficiency or heat recovery measures are given.

@Graphical illustration input EINSTEIN questionnaire

Required Data
Contact Data

- Contact information

Contact information:	
name of the company	
city	
name of contact person	
position of contact person in the company	
address	
Telephone No	
Fax No	
E-mail	

Required Data
Production and Energy Cost Data

- For each product:
  (include monthly consumption info when available)

Production information:		
Name of product	name	
Type of product	description	e.g. fruit juice
Annual production	Unit	
measurement unit for product quantity	Unit	

- For each energy source:
  (include monthly consumption info when available)

Energy source information:		
Energy source	name	e.g. diesel, natural gas, LPG, electricity
Anual consumption	unit	
LCV (when applicable)	unit	
Unit cost	Unit	
Annual cost	Unit	

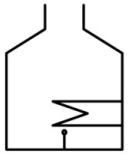
@Graphical illustration input EINSTEIN questionnaire

Required Data
Steam/Heat Generation

Equipment =	Example_boiler_type 1
Nr. of same units =	e.g., 3

Technical data of equipment:		
Fuel =	e.g., natural gas	
Nominal power =	?	kW (?)
Nominal fuel consumption =	?	kW (?)
Average usage factor =	?	%
Daily usage profile =	?	h/day
Yearly usage profile =	?	days/year

Heeat recovery from exhaust:		
Economizer installed?	Y/N	
Preheated medium	Water / air	
Preheated medium (cold stream)		
T_inlet =	?	°C
T_outlet =	?	°C
Mass flow		kg/s
Exhaust gas		
T_outlet =	?	°C



heating equipment

Stream connection of equipment:		
Generated heat transfer medium =	e.g., steam	
(e.g., high/low pressure steam, hot water, hot air, thermal oil, etc.)		
T_heat =	?	°C
T_return =	?	°C
p_heat (if relevant) =	?	bar (?)
p_return (if relevant) =	?	bar (?)

Please indicate if heating system is linked:
- directly to a specific process (which one?)
- or to a distribution line (which one?)

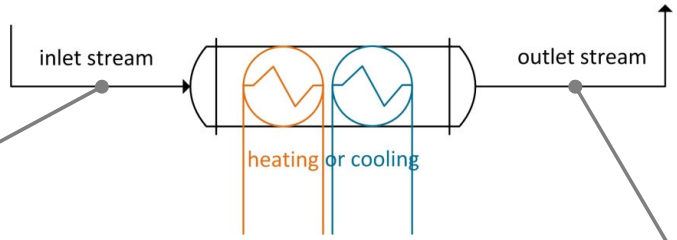
Additional information concerning connection:

(regarded essential to understand energy stream network)

@Graphical illustration input EINSTEIN questionnaire

Required Data
Input for Every Process

Process =	Example_cont_process 1



Inlet stream 1:		
Type of inflow =	?	
(e.g., raw material, chemical substance, water + ingredients, milk, etc.)		
T_in =	?	°C
m_in =	?	kg/s (?)
p_in (if relevant) =	?	bar (?)
(please copy&paste this table for every inlet stream)		

Inlet stream 2:		
Type of inflow =	?	
(e.g., raw material, chemical substance, water + ingredients, milk, etc.)		
T_in =	?	°C
m_in =	?	kg/s (?)
p_in (if relevant) =	?	bar (?)
(please copy&paste this table for every inlet stream)		

Outlet stream 1:		
Type of inflow =	?	
(e.g., raw material, chemical substance, water + ingredients, milk, etc.)		
T_out =	?	°C
m_out =	?	kg/s (?)
p_out (if relevant) =	?	bar (?)
(please copy&paste this table for every inlet stream)		

@Graphical illustration input EINSTEIN questionnaire

Required Data
Solar Related Data

- Information related with solar system installation requirements
  - Available area(s), location, inclination and orientation
  - Distance to possible heat delivery points (boiler, processes)
  - Access to available area
  - Foreseeable shadings
  - Rooftop type and resistance (minimum 25 – 40 kg/m2)
  - Access to water and electricity infrastructure
  - Existing solar field and components
  - Existing (unused?) thermal storage

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In-Situ Measurements

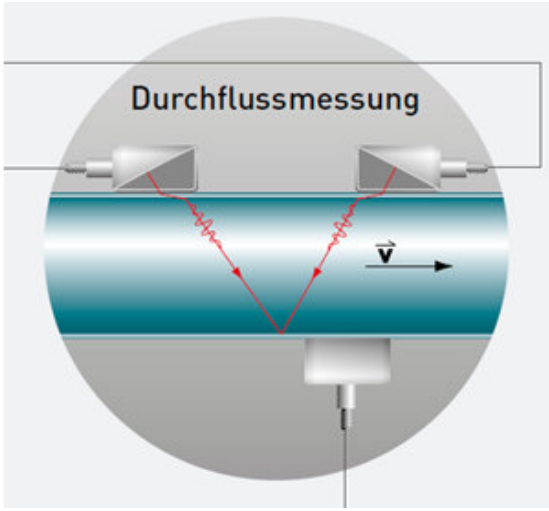
- Some companies have Energy Management Systems (EMS)
  - Relies on the installation of fixed equipment
  - Costly and takes a lot of time
- Still required information is often not available
  - Assumptions can be made
  - Measurements can be made with portable measurement devices
- Required measurement are mostly fluid flows (gas or liquid) and temperatures

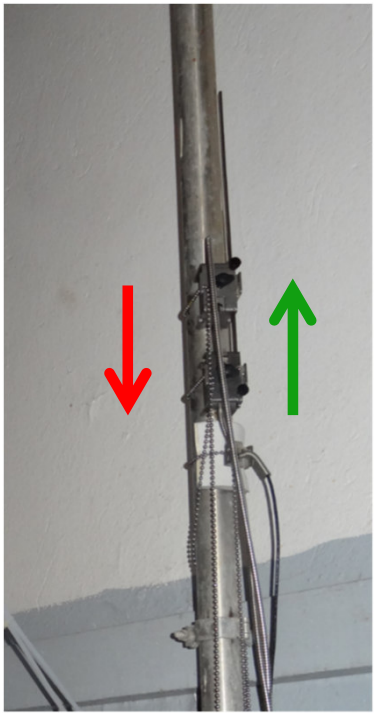
In-Situ Measurements
Portable Equipment: Air Flow

- Map flow profile (critical in larger sections)
- Objective: calculation of average airflow velocity

In-Situ Measurements
Portable Equipment: Fluid Flow

- Ultrasonic flow meter
  - Assure piping is full (installation on lower section)
  - Assure similar flow conditions between emitter and receiver





In-Situ Measurements
Portable Equipment: Temperature

- Thermocouples or PT100
  - Assure surface contact (thermal paste)
  - Assure insulation
  - Protection against radiation gains

In-Situ Measurements
Portable Equipment: Humidity

- Psychrometer or hygrometer

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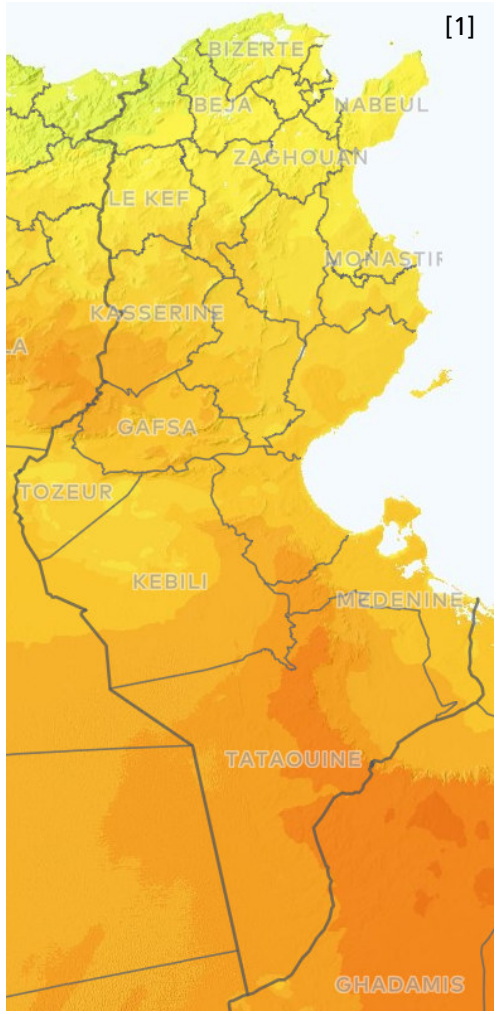
Examples
Companies

	Company 1	Company 2
Industry	Dairy	Textile
Annual energy consumption	20 GWh	24 GWh
Consumed thermal energy	49 %	51 %
Steam temperature	170 °C	170 °C
Steam pressure	8 bar	8 bar
Schedule	7 days/week	6 days/week
Current energy source	LPG	Heavy Oil
Current energy price	4.5 €Ct/kWh	2.5 €Ct/kWh



DNI resource Tunisia

➢ Suitable conditions for concentrating solar process heat!

[1] World Bank Group, Solargis, ESMAP, https://globalsolaratlas.info/

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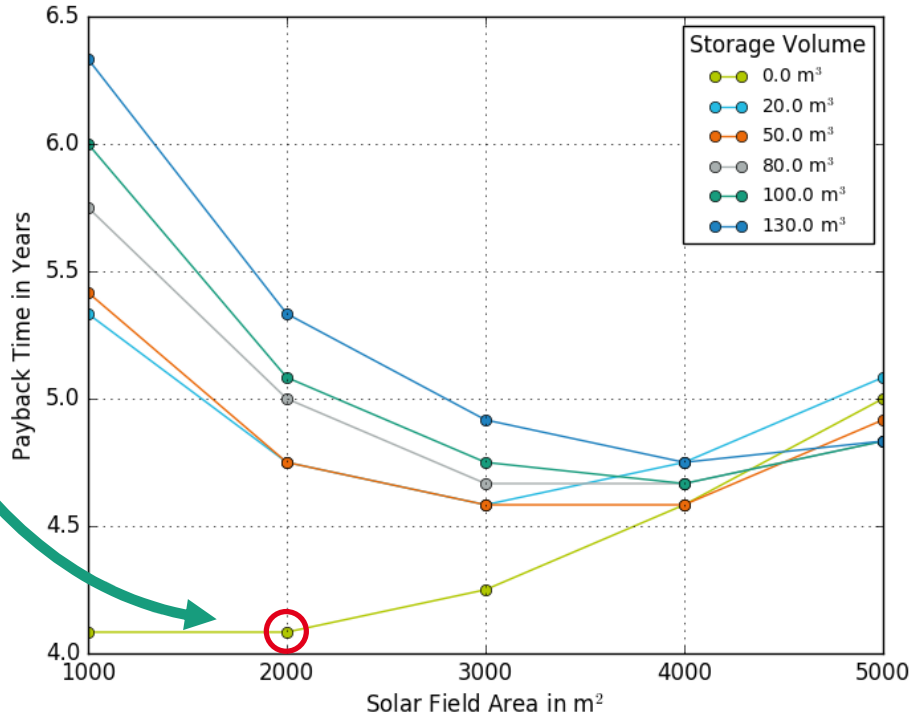
Examples
Techno-economic analysis

- Technical simulation study
  - for different solar field sizes
  - for different storage sizes

- Economical analysis based on
  - Simulation results
  - Financial parameters
    - Lifetime: 20 years
    - Solar field costs: 450 €/m²
    - Discount rate: 8 %
    - Variation of incentives: 20 – 80 % of CAPEX

Selection of ideal system design



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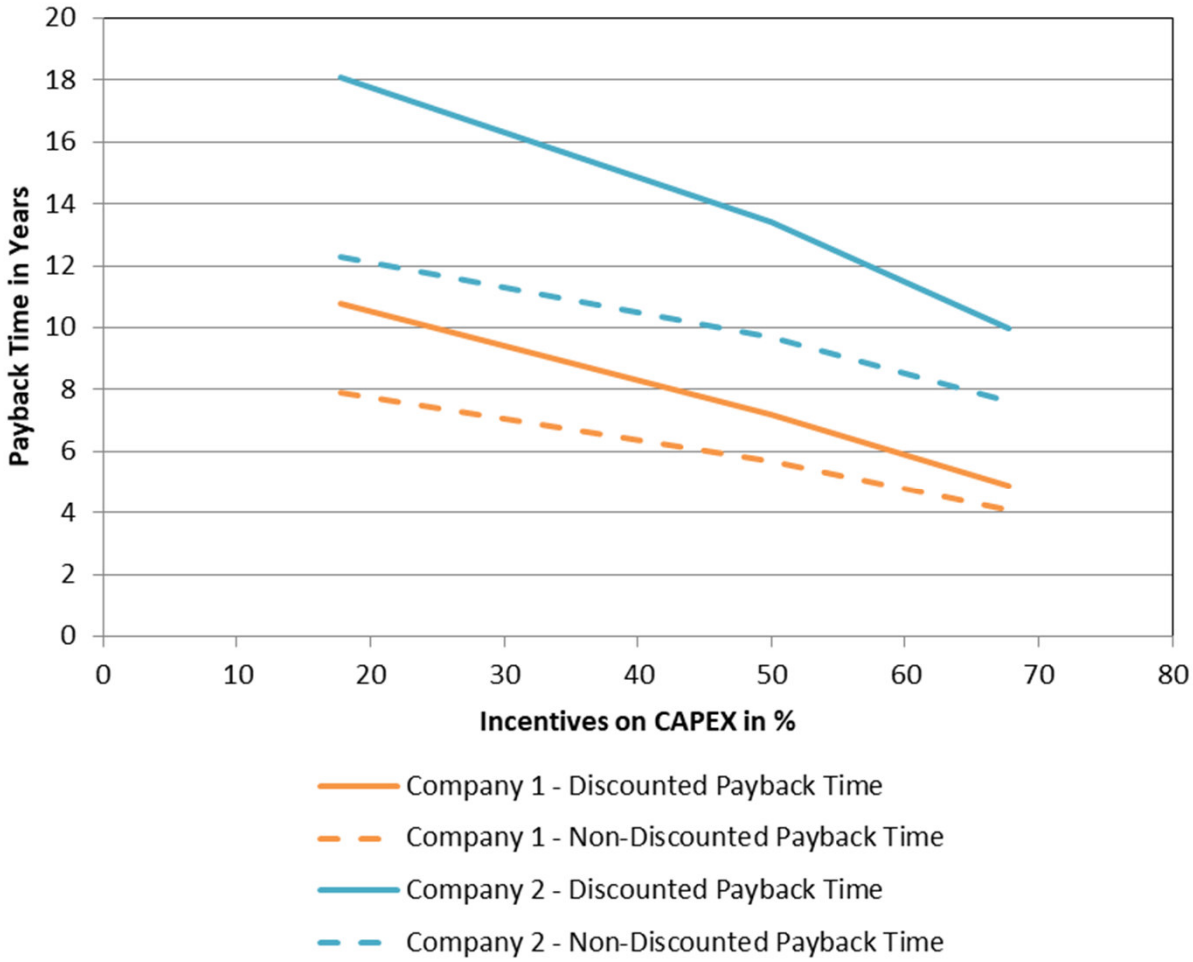
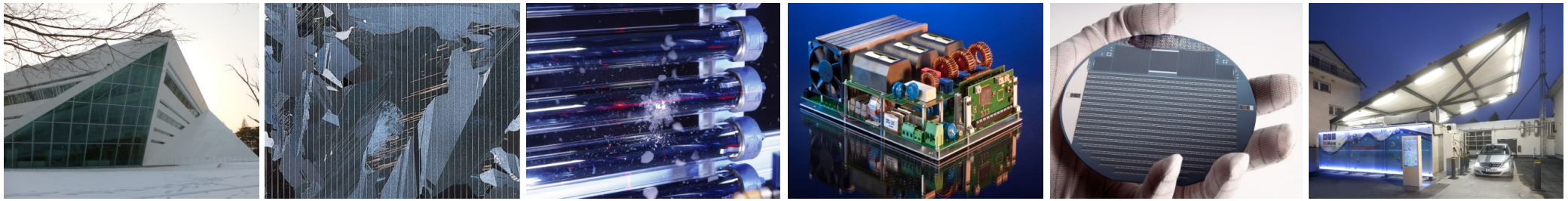
Examples
Financial results

- Payback times are
  - 4 - 8 years for company 1
  - 8 – 12 years for company 2



Thank you for your Attention!



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