# Study of opportunities for solar thermal systems in the tertiary and industrial sector in Tunisia





Supported by





German Solar Industry Association (BSW-Solar)

## Agenda

- 1. Presentation of consortium
  - 1. Institutions
  - 2. Prior experience in ST & Tunisia / MENA
- 2. Project approach: Desired outcome
- 3. Methodology & Simulation (DS, BG)
- 4. Data available so far and research requirements (DS, CAMI)
- 5. Next steps (BSW)



#### Consortium





#### The German Solar Industry Association



TASK To represent the solar industry in Germany in the thermal and photovoltaic sector

**VISION** A sustainable global energy supply provided by solar

(renewable) energy

**ACTIVITIES** Lobbying, political advice, public relations, market

observation, standardization

**EXPERIENCE** Active in the solar energy sector for over 30 years

**REPRESENTS** More than 800 solar producers, suppliers, wholesalers,

installers and other companies active in the solar

business

**HEADQUARTERS** Berlin

## vaLentin software

#### Valentin Software GmbH



- Established 1988
- Software development of design, simulation and modeling tools for photovoltaic and solar thermal systems
- Standard & customized software
- 30 employees (of which over 50% are engineers and developers)



A dynamic simulation program for the design and calculation of photovoltaic systems, including grid-connected, off-grid and battery packed-up systems.



A dynamic simulation program for the design and optimization of solar thermal systems, for applications including space heating, domestic hot water, pools and industrial usage.

## Ing. Detlev Seidler



Diploma thesis:

Development of a stratifying tank for solar applications

#### More than 20 years of experience:

- Planning engineer
   Planning and operation of cogeneration plants
- Project development
   ESCO projects in industry
- General manager
   Sales for large scale solar systems
- Head of sales Germany
   Sales for large scale solar systems
- Further solar activities
   Speaker of the BSW working group on solar process heat member of IEA task 49 (process heat)

#### **CAMI**



ISO 9001 - 2000

Ing. Mr. Abdelhak Kemiri

#### 25 years of experience in:

- Engineering
- Energy Audits & Energy Saving
- Assistance and Coordination of Industrial Project Tasks
- Industrial Maintenance Services

Vast experience with energy audits and efficiency consulting

#### Task in the project:

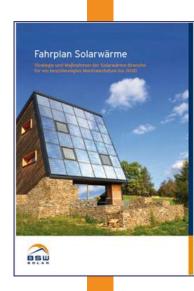
Provision of local expertise and data

## Prior experience

## BSW

#### Solar Thermal:

- GroSol-Study: Study of large solar thermal system for multi family houses in Germany (2007)
- SoLarge: Analysis on large solar thermal multi family houses in multi family houses in 6 countries of Europe (2006 2008)
- Solar Thermal Research Roadmaps for Europe (2008) & Germany (2010)
- Solar Thermal Market Development Roadmap for Germany (2011 / 12)
- Process Heat: Study of cost competitiveness of solar thermal for industrial processes in Germany (2012/13) with Fichtner Gmbh





## Prior experience of BSW-Solar

#### PV

- Numerous studies and roadmaps processes for Germany
- Consultancies, Workshops & Studies in India, Indonesia, Sub-Sahara-Africa, Latin America
- PV Legal 2009 12: Study & policy recommendations to reduce political barriers in 12 European countries
- PV Grid 2012 14: Study & policy recommendations to reduce technical barriers in 17 European countries

#### Enabling PV (2014)

Cost & profitability analysis, simulations and (policy) recommendations as well as guideline for investors in

- Brazil
- Jordan
- Tunisia



The Emerging PV Market in Jordan









## Project:

Study of opportunities for solar thermal systems in the tertiary and industrial sector in Tunisia (Sept. to Nov. 2014)





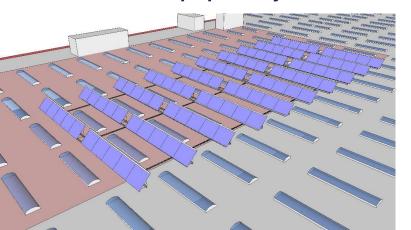
## Goal of the study



 Identify economic opportunities for solar thermal system in the tertiary (forced circulation) and industrial sector in Tunisia

 Define scenarios for economic opportunities as a basis to define promising market segments

Develop policy recommendations



#### **Activities**



- Collection of relevant information on:
  - Different ST technologies (flat plate / vacuum tube / concentrating systems) to provide technical recommendation for Tunisia
  - ST-System costs for local / foreign products
    - Collectors, storage, overall costs
  - Relevant applications for ST in different industries / branches
  - Competing heat generation sources in those branches
- Profitability & sensitivity analysis for ST systems in different applications in Tunisia for industrial and tertiary sector including
- Comparison with conventional technologies



Identified Market Segments & Technologies

#### Industry

- Agriculture
- Textile
- Chemical
- Brickworks

#### **Tertiary Sector**

- Hotel
- Hospital
- Multi family houses
- Thalasso

#### **Technologies**

- Flat plate / Vacuum Tube Collectors, Fresnel Concentration Collectors
- Applications with / without heat storage



## Processes to be investigated: Solar Integration



#### Steam

- supply level is most suitable
- only 1 big solar system (needed space available?)
- storing the steam is nearly impossible
- for concentrating solar systems
  - minimum size 500 m<sup>2</sup>
  - economy of scale: 2.500 m<sup>2</sup>++

#### Hot water

- integration on the consumer level is possible and more effective
- solar fraction might be lower, because not all processes can be served
- 2 smaller systems instead of 1 big system if suitable storing the heat is easy
- for non concentrating solar systems
  - economy of scale: 1.000 m<sup>2</sup>++

## Industry: possible cases



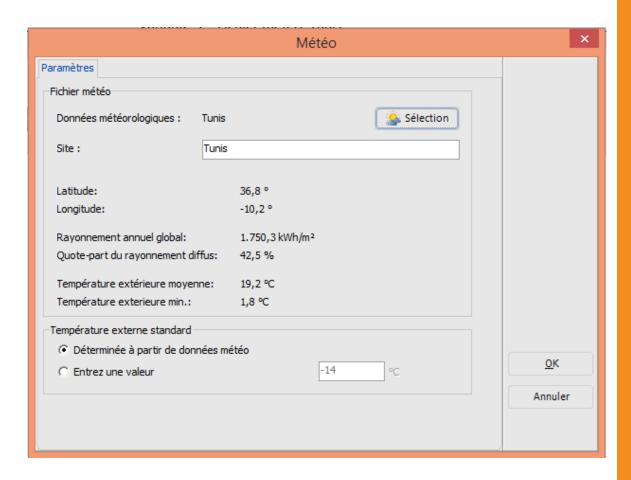
- Relevant criteria?
- Representative consumption?

branch	climate zone	fuel	supply level	consumer level	demand		
	DNI level		yearly demand				
10.0	mlata a d Nlaud				225 days /24 b		
IAA 	plateaux du Nord		steam		335 days /24 h		
Foods	costal	fuel oil	14.000 MWh/a	28% at 25/90°C	fluctuating		
ICH			steam				
Pharmaceutics	mediterrainian	natural gas	9.000 MWh/a	100% at 70/80°C	24 / 7		
ПСН			steam		7 to 22:00 (4.500h/a)		
Textile	mediterrainian	natural gas	12.600 MWh/a	60 - 95 °C	3 weeks holidays		
ID Tabac	plateaux du Nord	natural gas	steam		only 178 days 5:00 to 14:30		
IAA Foods	mediterrainian	natural gas	steam		during Summer not 7:00 to 13:00		
IAA Dairy	mediterrainian	natural gas	superheated water 60/140°C	air 80°C	24/7		
, Dan y			steam	air / vapeur 110°C	24 / 7		

## Appliance to Tunisia

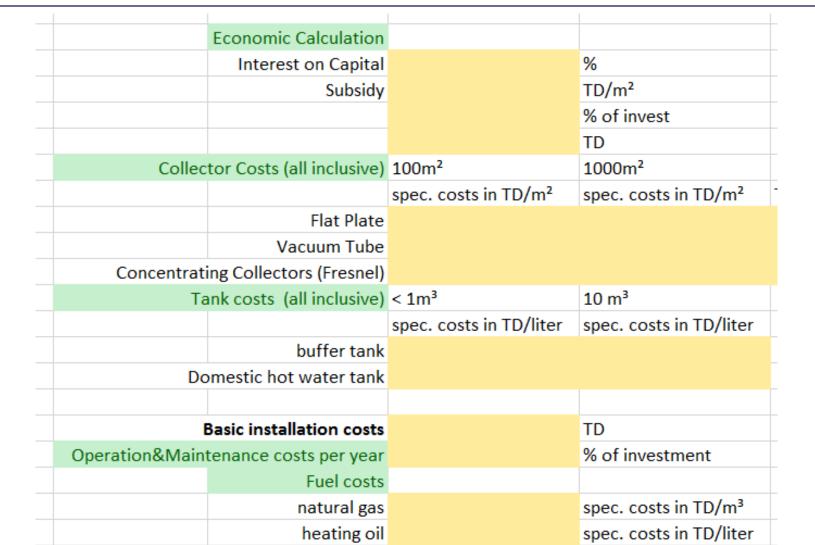


- Meteo dataset
- Economic boundary conditions
- Case studies



## Economic boundary conditions

Cost escalation rate





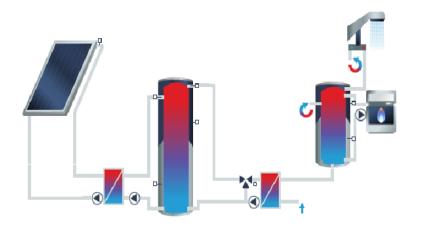
#### Case studies



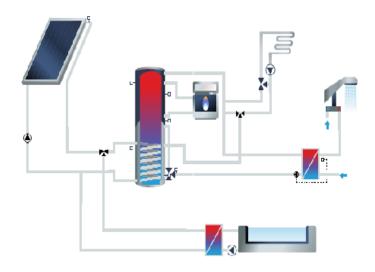
Sector	ID	Project type	Solar supported demand	T*SOL system type	Collector technology
Tertiare Sector	TS1	Hotel	Domestic hot water	C3	Flat plate, tubes
Tertiare Sector	TS2	Hotel	DHW, heating and indoor pool	B17	Flat plate, tubes
Tertiare Sector	TS3	Hospital	Domestic hot water	C3	Flat plate, tubes
Tertiare Sector	TS4	Hospital	Saturated steam	A15.1	Tubes, Fresnel-Collector
Industrial Sector	IS1	Process Heat	Hot water 40-60°C	A14.1	Flat plate, tubes
Industrial Sector	IS2	Process Heat	Hot water 60-80°C	A14.1	Flat plate, tubes
Industrial Sector	IS3	Process Heat	Hot water 20-80°C	A14.1	Flat plate, tubes
Industrial Sector	IS4	Process Heat	Saturated steam	A15.1	Tubes, Fresnel-Collector

## Hydraulic Schemes

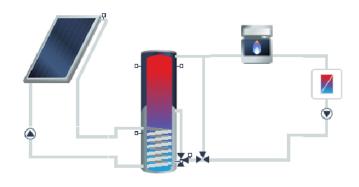




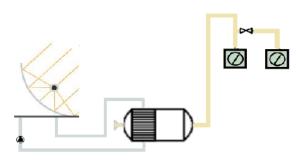
C3 - Large-scale DHW system with standby tank and heat exchanger



B17 - Buffer tank system with fresh water station and swimming pool



A14.1 - Buffer tank system with process heating and continuous-flow heater



A15.1 Steam generator (kettle type)

## Necessary technical input



- Thermal demand for
  - Domestic Hot Water
    - Temperature monthly consumption, profiles
  - Heating
    - Monthly heat, basic building parameters
  - Indoor Pools
    - Pool area and depth, temperature, persons a day, ...
  - Industrial Heat and Steam
    - Temperature level, Monthly consumption, profiles
- Important: Typical profiles of demand

#### 1

## Technical data e.g. heating demand of a building (tertiary sector)



ricutii	ng Demand				P	rofile	in % o	f the	annua	l de
			Jan	Feb	_	_	May		_	Αu
	Total heat demand	kWh								
	Total Heating Area	m²								
	Indoor temperature	°C								
	Specific internal heat gains	w/m²								
	Heating Period	e.g. 1.10-31.3.								
	Night Period without heating	e.g. 10:00-6:00								
	Window Area									
	East	m²								
	South	m²								
	West	m²								
	North	m²								
	Window type									
	type	descriptional text								
	shadow factor	%								
	glass proportion	%								
	U-value	W/m²/K								
	G-value	%								

## Technical data industrial processes



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ed	kW					
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on						
on	e.g. 1.731.7.					
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## Sensitivity Analysis



- Applied to each case study
- Dynamic input parameters:
  - Size of collector field (solar fraction)
  - Load factor
  - Fuel costs
  - Financing costs
  - Subsidy ratio
- Output parameters:
  - Levelized heat generation costs (TD/kWh)
  - Payback period in years
  - Net-present value
  - Internal rate of return

## Results of sensitivity analysis



- Presented for each case study
- Tables with technical result
  - Solar System yield
  - Efficiency, Solar fraction
  - Saved fuels
- Chart for each output parameter showing the dependency on the dynamic input parameters
- Critical values for economic viability



#### Chapter

- 1. Executive Summary
- 2. Introduction
  - Solar Thermal Market Profile / Institutional Framework
  - Levelized heat generation costs of conventional technologies (natural gas / oil / co-generation, subsidies)
- 3. Solar Technologies
- Heating and Cooling
  - Heat integration methods
  - Solar air conditioning and cooling
- Collector types:
- Flat plate collector / Evacuated tubes / Concentrated Fresnel / Concentrated Parabolic / trough / Absorber
- Conclusion: most frequently applied technologies (incl. Matrix)



#### 4. Relevant applications in Tunisia

#### tertiary sector

- Sector 1: energy supply, process, temperatures, location specifics, heat costs, relevance of energy costs, investment behavior (incl. accepted criteria of economic viability)
- Sector 2-4...

#### industrial sector

- Sector 1: energy supply, process, temperatures, location specifics, heat costs, relevance of energy costs, investment behavior (incl. accepted criteria of economic viability)
- Sector 2-4 ...
- Conclusion: Selection of applications for further analysis

#### 5. Case Studies

- Overview of selected cases
- general boundary conditions (climate zones / irradiation, prices)
- method of economic analysis (output parameters, optimum definition)
- description of T-Sol
- Case 1
  - case-specific input parameters
  - solar system description
  - results (incl. sensitivities) and economic optimum (recommended design and dimensioning)
- Case 2-8...
- Conclusions of case studies



#### 6. Economic conclusions

- evaluation of cases
- optimum scenario
- recommended technologies
- comparison with conventional technologies
- conclusion

#### 7. Market potential

- method (based on energy audit data / sample solar fraction of recommended technology)
- potential per sector
- recommendations on how to transfer technical in economic potential

#### 8. Political recommendation

- barriers and challenges from an economic perspective
- investment requirements
- subsidy and framework requirements
- final recommendations derived from optimum scenario

## Which information is missing?



## Merci beaucoup pour votre attention!



