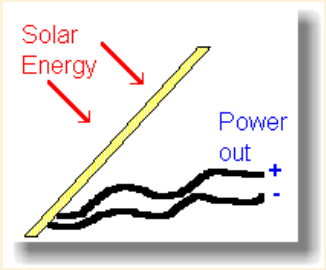
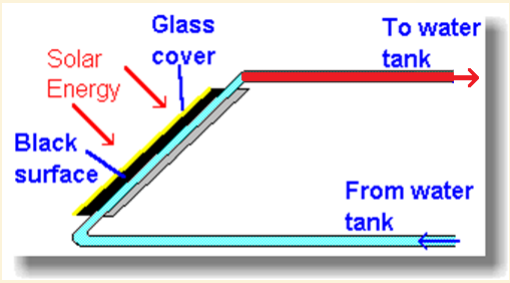
Large Solar Thermal Energy Systems for Cooling and Heating

S.O.L.I.D. works on Solar THERMAL

- Solar PV (Electricity)

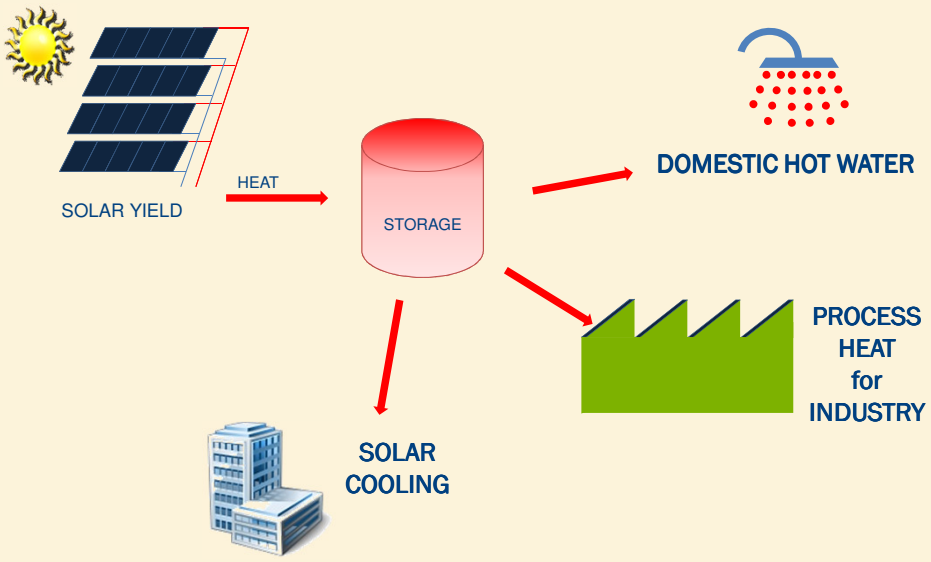


- Solar Heating (Heat)



> 500 % higher output per m² !

Technical Solutions by SOLID



System Integration by S.O.L.I.D.

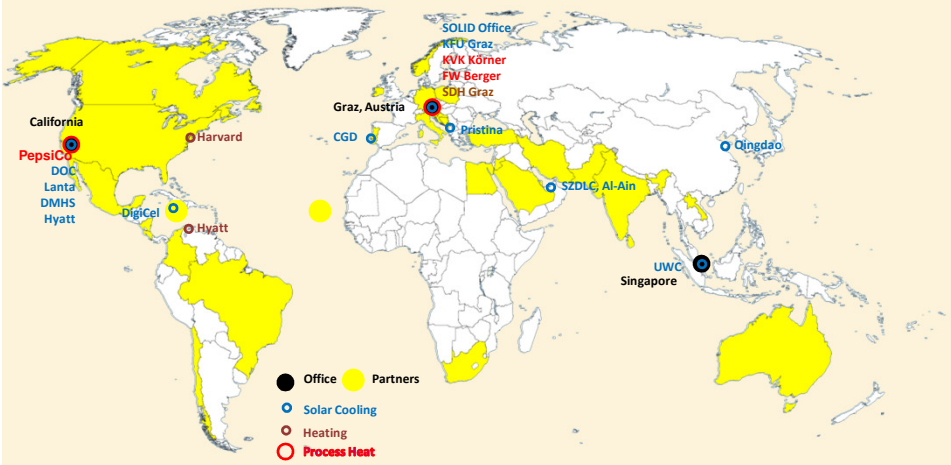
Large solar thermal systems (> 500 m² / 5,000 ft²)

- Project development
- Design & engineering
- Construction
- Operation & maintenance
- Financing (ESCo)
- Research & Development

S.O.L.I.D. Group

Headquarter in Graz, Austria
Subsidiaries in USA & Singapore

Partners in many other countries
300 reference plants around the world



Solar Thermal Collectors

SOLID cooperates with the major collector producers in collector development and realization of projects.

The best is chosen case by case for each specific project site.

Collector field test at Fernheizwerk Graz, Austria: 2500 m², 4 different suppliers

Domestic Hot Water

SOLID Examples

Hyatt Regency, Scottsdale, AZ

Resort and Spa

Hot water preparation

Solar Panels: 283.5 m²

Harvard, Cambridge, MA, USA

University Campus
2 Housing Buildgs.
82+16 apartments

50.4 m² / 543 ft² at Broadway
94.5 m² / 1017 ft² at Prescott

Domestic hot water

Solar Process Heat

SOLID Examples

Gatorade (Pepsi Cola) Phoenix , AZ

Preheating production water for the soft drinks before the reverse osmosis plant.

Storage: 38 m^3

2008: 893 m^2

2010: upgrade to 2600 m^2

2012: upgrade to 3700 m^2

Next step to integrate Solar Heat in the pasteurization in planning phase today

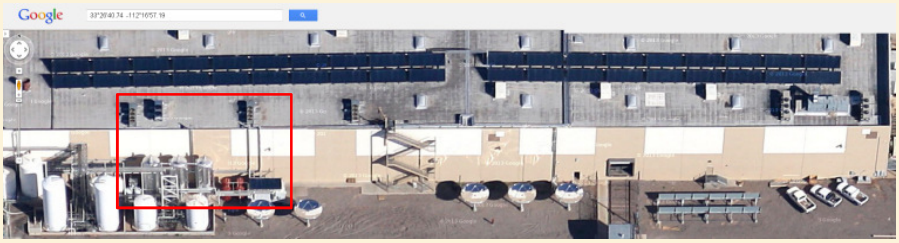
Gatorade (Pepsi Cola) Phoenix , AZ

2009

2011

2012

Gatorade (Pepsi Cola) Phoenix , AZ



Solar Thermal system:

- 30,000 gal/110 m³ storage
- 20 ft container for pumps and controls
- Expansion tanks

Meat factory Berger, Austria

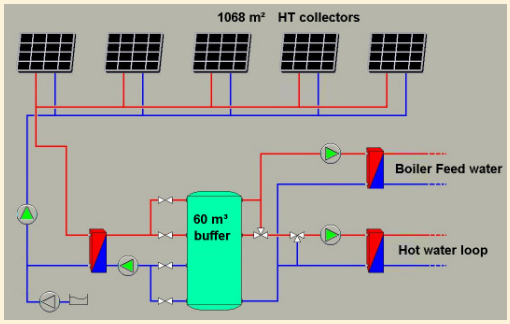
- 1067 m² HT flat-plate collectors
- Guaranteed solar yield: 400 kWh/(m²*year)
- European funded – Research and best practice demo project
- Commissioned in June 2013

Meat factory Berger, Austria

80 – 90 tons/day of meat and sausage products

Heat for dehumidification of maturation chambers

- 160 m³ daily consumption
- Usage of waste heat @ 40° C
- Solar heating up to 60°



Preheating feed water for steam production (ham cooking)

- 25 m³ daily consumption
- Usage of waste heat @ 40° C
- Solar heating up to 98°

Meat factory Berger, Austria

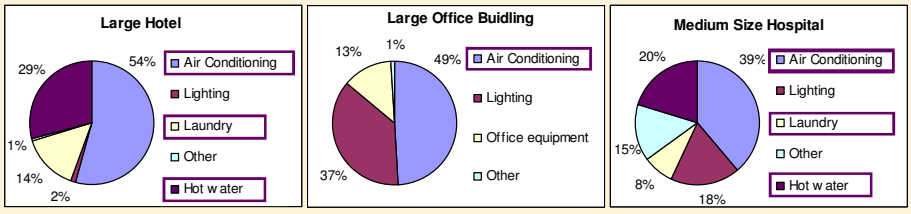
www.tinyurl.com/Berger-GBE-Video

Solar Cooling

Why & How ?

Why solar air conditioning ?

- The buildings sector accounts for 42% of global electricity consumption (IEA 2007)
- Air-Conditioning (AC) represents the biggest single energy/power consumer in public and commercial sectors
- AC key driver of electric peak power demand growth → negative impact on grid load factor, electricity price and environment



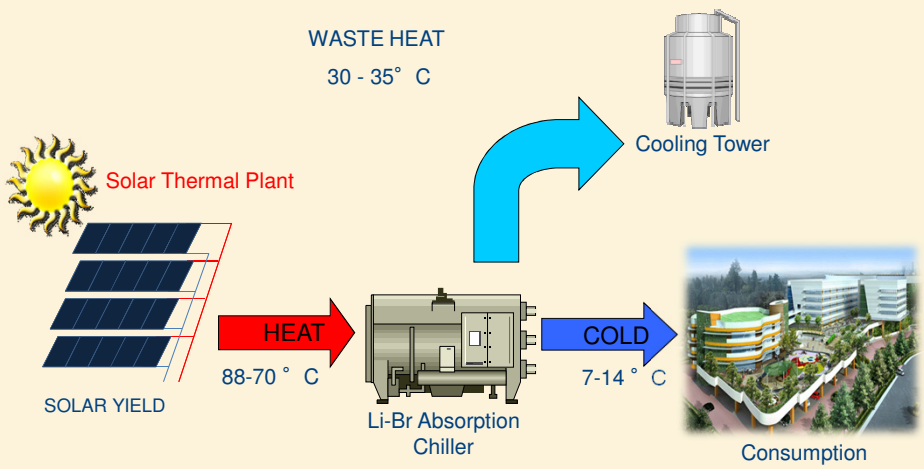
Solar Cooling – the advantage

peak of solar radiation and
peak of cooling demand
match perfectly

- We can use the same radiation that creates the cooling demand to cover it.
- Avoids electricity peaks and extreme operations on the electric distribution grid.
- Solar Cooling saves the most expensive electricity
- Approx. 75% of the UAE electricity production is spent for Cooling !!!

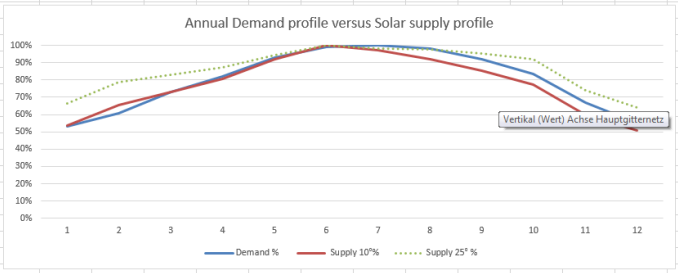
LiBr Absorption Chiller & LST

Nominal Temperature Levels and Power Requirement at external Interfaces



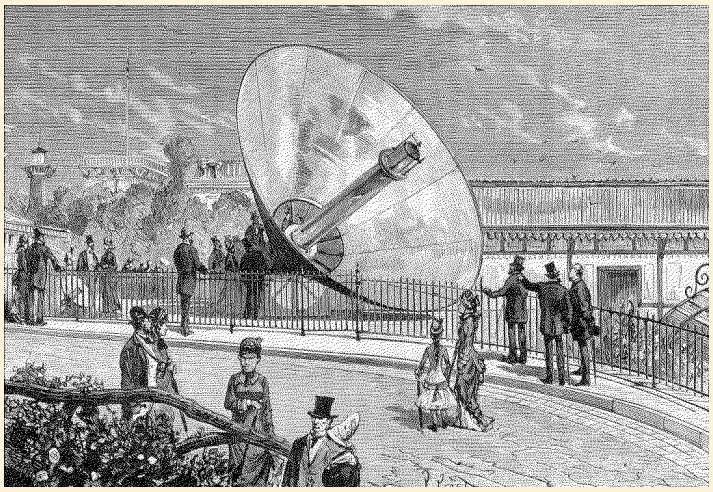
Cooling Load & annual Solar Supply

	jan	feb	mär	apr	mai	jun	jul	aug	sep	okt	nov	dez	year	
Demand Elevated Load Case 2	4885	5599	6706	7564	8574	9138	9205	9051	8453	7667	6144	5072		[kWh/day]
Demand %	53%	61%	73%	82%	93%	99%	100%	98%	92%	83%	67%	55%		
Nasa irradiation 10°	4,07	5	5,57	6,15	7,01	7,61	7,38	7,01	6,48	5,87	4,55	3,87		[kWh/m² day]
Supply 10°%	53%	66%	73%	81%	92%	100%	97%	92%	85%	77%	60%	51%		
Nasa irradiation 25°	4,61	5,46	5,75	6,04	6,54	6,92	6,79	6,76	6,59	6,36	5,12	4,43		[kWh/m² day]
Supply 25° %	67%	79%	83%	87%	95%	100%	98%	98%	95%	92%	74%	64%		
Supply 10° versus Demand	1,01	1,08	1,00	0,98	0,99	1,01	0,97	0,94	0,93	0,93	0,90	0,92		
Supply 25° versus Demand	1,26	1,30	1,14	1,06	1,01	1,01	0,98	0,99	1,04	1,10	1,11	1,16		



Target value of > 80% Solar coverage fits well to typical Arabian cooling load profile

A brand new technology ?



World Expo 1878 in Paris, A. Mouchot produces ice with solar energy

Solar Cooling

SOLID Examples

Solar cooling references

Location/Project	Cooling Machine	Constr.	Cooling Power	Collector Area
EAR Tower, Pristina, Kosovo	LiBr-Chiller	2002/3	90 kW	226 m²
Wine Cooling , Leutschach, Austria	Ammonia	2003	10 kW	100 m²
Graz – office, test Plant	Ammonia	2003	2 kW	8 m²
Stadtwerke, Crailsheim, Austria	LiBr-Chiller	2004	15 kW	500 m²
Renewable Energy House, Brussels, Belgium	LiBr-Chiller	2005/7	35 kW	60 m²
Desert Outdoor Center, Phoenix, USA	LiBr-Chiller	2006	70 kW	126 m²
Olympic Village, Qingdao, China	LiBr-Chiller	2006	512 kW	638 m²
Estellas Restaurant, Tampa, USA	LiBr-Chiller	2007	70 kW	210 m²
CGD Office Building, Lisbon, Portugal	LiBr-Chiller	2008	545 kW	1579 m²
Warehouse, Lanta, Phoenix, USA	LiBr-Chiller	2008	130 kW	504 m²
Service Center Municipality, Gleisdorf, Austria	LiBr Chiller & DEC	2008	35 kW	260 m²
New Office, Graz, Austria	Li Br Chiller	2008	17.5 kW	58 m²
Metro MAN, Istanbul, Turkey	LiBr Chiller	2009	Study	
Sheikh Zayed Desert Learning Center, UAE	LiBr Chiller	2010/12	400 kW	1108 m²
United World College, Singapore	LiBr Chiller	2010/11	1470 kW	3900 m²
DigiCel, Kingston, Jamaica	LiBr Chiller	2012	600 kW	982 m²
Desert Mountain High School, Scottsdale, USA	LiBr Chiller	2013/14	1750 kW	4865 m²
University Graz, Chemistry building, Design & Consultancy	LiBr Chiller	2014	105 kW	636 m²

EAR Tower Pristina, Kosovo

2 LiBr absorption machines, total capacity of 70 kW / 20 tons

Solar Panels: 226 m^2

4 m^3 storage tank

Operating since Feb. 2003

14^{th} operating season, 0% unforeseen down time

Sheik Zayed Desert Learning Center (UAE/Al Ain)

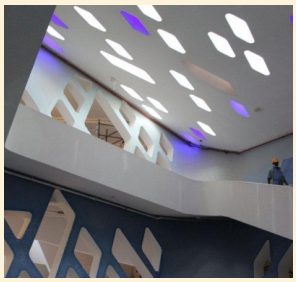
Solar Cooling via concrete core activation of a desert museum

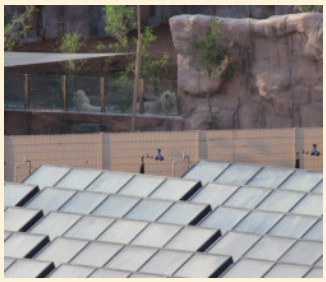
Cooling power: 400 kW

Collector area: 1108 m^2

Expected Solar yield: 825 kWh/m^2/year

Commissioning: 2012





Sheik Zayed Desert Learning Center (UAE/Al Ain)

Sheik Zayed Desert Learning Center (UAE/Al Ain)

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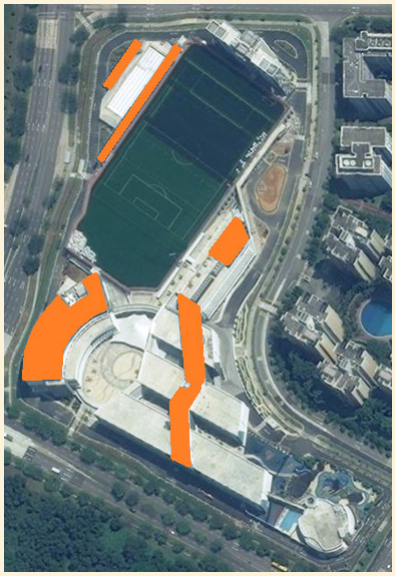
UWC Tampines, Singapore



Solar Cooling & Hot Water for School Campus

Solar Panels:
3900 m² / 2.73 MW

LiBr absorption chiller:
1470 kW

Operation started: 2011

Enlargement actually under discussion

World's most powerful Solar Cooling System until 2013

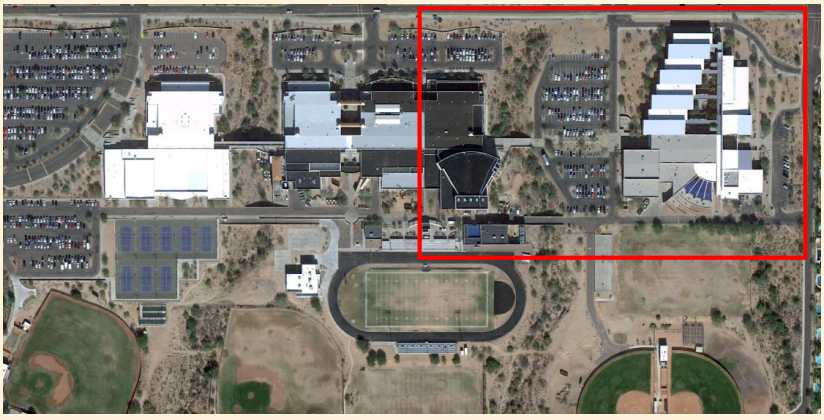
UWC Tampines, Singapore

UWC Tampines, Singapore

Desert Mountain High School, USA

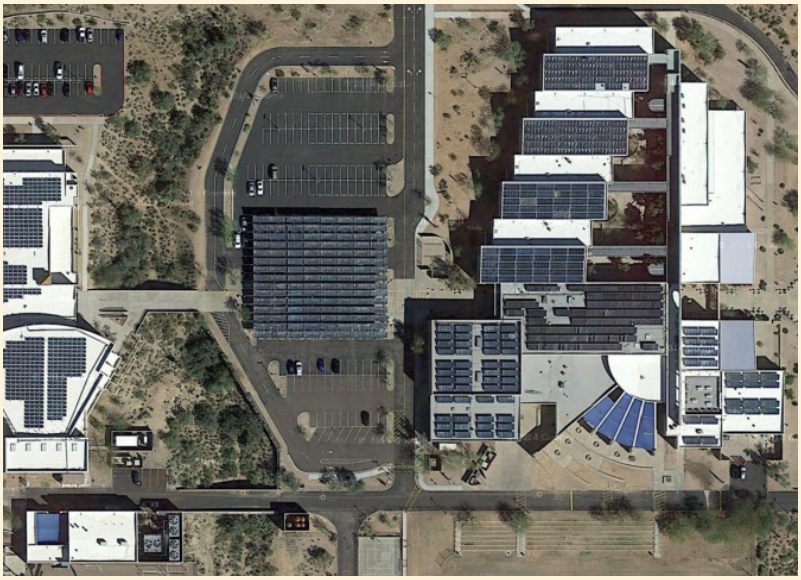
Scottsdale, Arizona, USA
Solar Cooling for Middle School and High school

20% larger than SOLID's Singapore project



Desert Mountain High School, USA

Desert Mountain High School, USA



Google Maps, March 8th 2014

Desert Mountain High School, USA

Solar Panels: 4,865 m² → 3.4 MW

Cooling load: 500 tons /1750 kW

In operation since 2014

World's most powerful Solar Cooling System

Desert Mountain High School, USA

Results after one full year of operation:

- Chiller $COP_{thermal}$ 0.75
- Peak Hour $COP_{electric}$ 42 (0.08 kW/RT)
- Annual $COPs_{electric}$ 25 (0.14 kW/RT)

How to achieve these results?

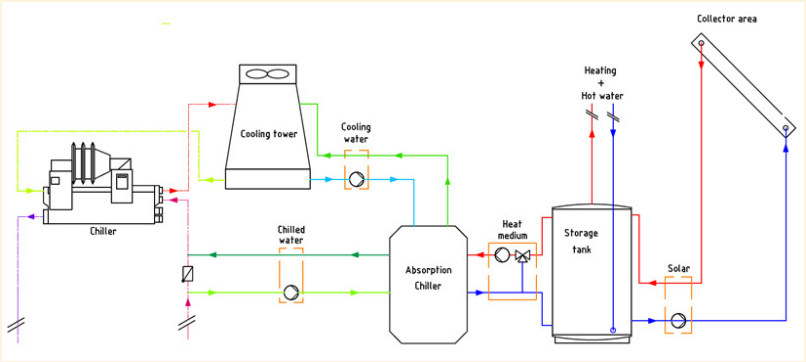
- Learn how to run Chillers and Cooling towers within and beyond manufacturers specs !
- Develop intelligent control strategies adapted to Solar Thermal heat input profile, starting and stopping heat supply every day.
- Benefit from desert climate

MODON School, KSA

MODON Prototype School – Living Communities, KSA

Solar Cooling and Heating planned by MENABEX/SOLID .

MODON School, KSA



Efficiency comparison:

MODON AC system report (2).pdf - Adobe Reader

	Description	Chilled Water		DX- Refrigerant system			
		Water cooled	Air cooled	VRV /VRF	Split Units	Package Units	Window Type
2	Operation Cost Electricity Kw/ton approx.	0.7- 0.8	1.7- 2	1.4-1.6	2.1-2.5	2- 2.3	2.1- 2.5

SOLID Solar Cooling

proven **0,14 kW/RT**

MODON School, KSA

Complete package of Solar technologies

Solar Electricity by Austrian KPV

Nominal Capacity 786 $kW_{electricity}$

Solar COOLING and Hot Water by SOLID

Nominal Capacity 1800 $kW_{heating}$

Nominal Capacity 260 $RT_{cooling}$

MODON Living Communitites

Sample numbers Cooling:

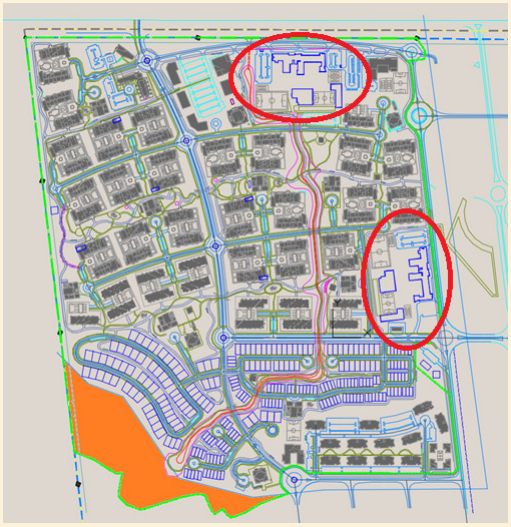
Marked area: 76,000 m² hilly land

Collector area: 50,000 m²

Equal to 5,000 RT cooling capacity during sunny peak hours

Best support for district cooling

10 times the size of world's biggest Solar Cooling project today



Keep Cool – Use the sun !

S.O.L.I.D. Gesellschaft für Solarinstallation und Design mbH
Puchstrasse 85, 8020 Graz, Austria
CEO: Christian Holter & Franz Radovic
Tel: +43 316 292840-0
Fax: +43 316 292840-28
Email: office@solid.at
http://www.solid.at

Harald Blazek
h.blazek@solid.at
Tel: +43 316 292840-29