TVP SOLAR
Thermal Vacuum Power

TVP Solar Corporate Introduction

“A new, carbon free thermal energy source competing with fossil fuels”

January 2017

SAINT-GOBAIN NOVAM
2009 ENERGY AWARD WINNER

inter solar award 2012 WINNER

WIPO 2012 AWARD INNOVATIVE ENTERPRISE

TVP Company Profile

TVP Solar SA is a Swiss company which designs, develops, manufactures and markets innovative high-vacuum flat solar thermal panels based on patented IP

Headquarter and R&D are based in Geneva, manufacturing in Avellino (Italy), direct sales in Rio de Janeiro and Singapore, sales partners covering 15 countries

Mission: to establish high-vacuum, flat panels as the reference technology in solar thermal industry and compete with fossil fuels

Business Model and Key Strategies

What TVP sells

- ✓ High-vacuum flat solar thermal panels for large scale deployments
  - To be integrated into heating, cooling and desalination systems
  - For 24/7 operations solar is hybridized with LNG, LPG, diesel and biogas

How and who TVP sells to

- ✓ Direct sales to large accounts (e.g. oil & gas, real estate developers)
- ✓ Via business-to-business sales partners
  - HVAC system integrators, energy efficiency resellers, EPC, utilities, ESCO
  - Application machine manufacturers (absorption chillers, boiler, desal machines)

Go-to-market

- ✓ Solar Air Conditioning as entry app
- ✓ Industrial process heat, thermal desalination are other priorities
- ✓ Oil & Gas as entry industry
- ✓ Warehouses, shopping malls, data centers, hospitals are key verticals
- ✓ Geographical focus:
  - ✓ high irradiance countries with high cost of electricity and/or grid constraints (such as GCC, Brazil, India, Egypt and SW USA)
  - ✓ low irradiance countries with solar thermal-specific incentive schemes (such as the Italy, France, Germany, Denmark, Singapore)

How TVP produces its products

- ✓ Owned & controlled Reference Manufacturing Module (up to 122.000 m^2/year)
- ✓ RMM replicas (to exceed 1M m^2/y): from 2020

How TVP maintains technology leadership

- ✓ New product development
- ✓ Furthering with innovation, IP generation and patenting

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Breakthrough Technology for Solar Thermal

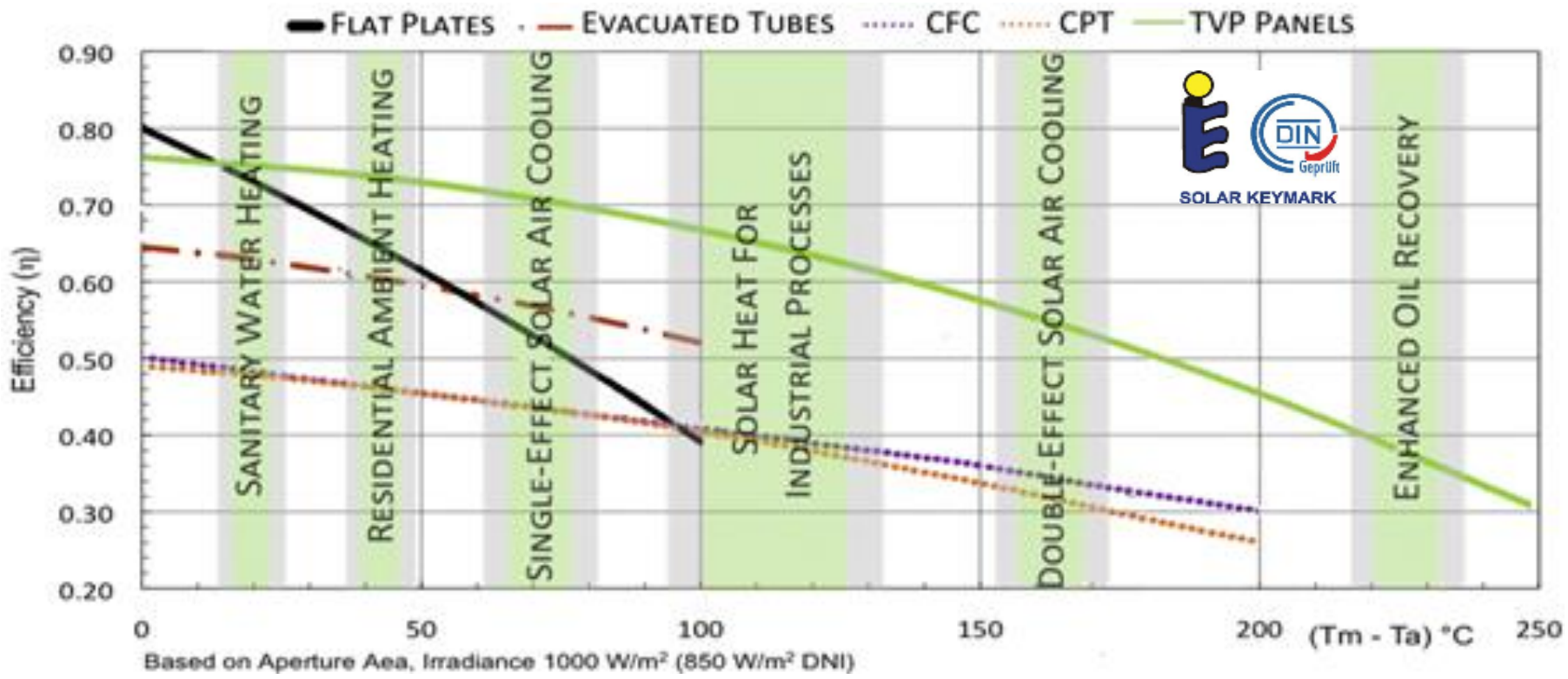
TVP introduces high-vacuum insulation in solar thermal flat plates

High-Vacuum Flat Solar Thermal Panel

- ✓ **Core technology combines high-vacuum insulation with planar layout**
  - ✓ Providing unrivalled performance in any climate conditions:
    high-vacuum completely suppresses convection losses and planar geometry keeps direct flow of thermal exchange fluid entirely under-vacuum
  - ✓ Realizing the cheapest commercially available products:
    same materials as flat plates and high-yield fully-automated mass manufacture process as displays (CRT and PDP)
- ✓ **TVP's technology is based on 10 granted patents**
  - ✓ Core patents refer to new glass-metal sealing technology and self-regenerating non-evaporable getter pump
  - ✓ Other patents cover technology, products and manufacturing process IP

The Most Performant Solar Thermal Energy Source

Certified best performance up to 200°C under SolarKeyMark

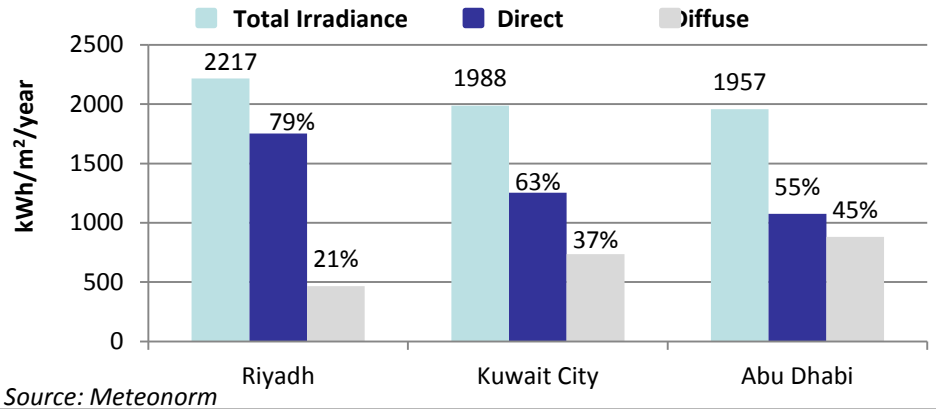


Highest performance at any operating temperature, any light condition, for every thermal application

TVP Unique Feature: No Water-Based Cleaning Required

Operates consistently in extreme diffuse light conditions without cleaning

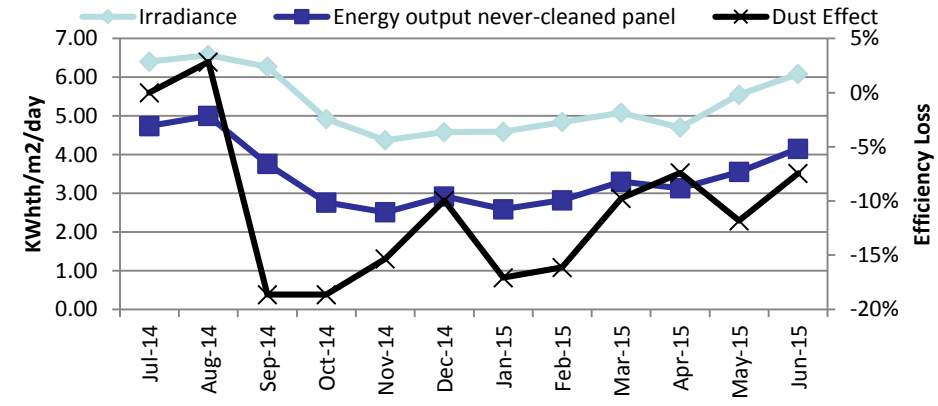
TVP captures both direct and diffuse light



Source: Meteonorm

Dust accumulation increases sunlight scattering (diffuse)

Dust accumulation only affects TVP efficiency up to 20%

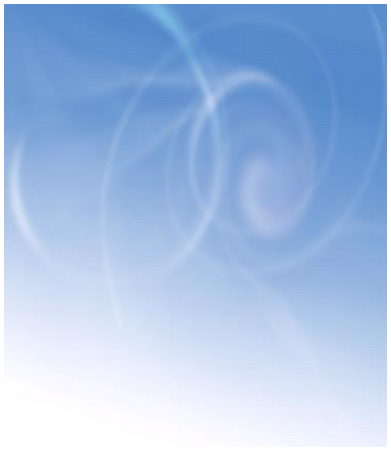
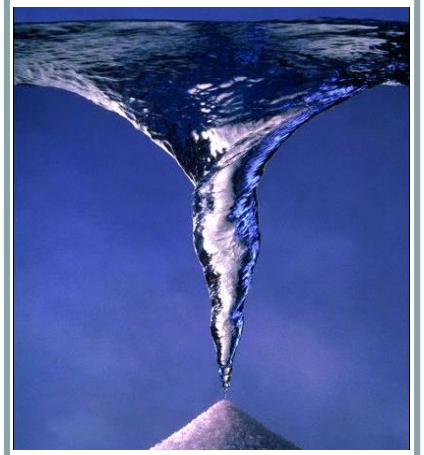


Source: TVP, IEA SHC

No cleaning is required by TVP panels

New Applications Driven By TVP

Driving high energy demanding applications requiring > 100°C and large scale solar fields

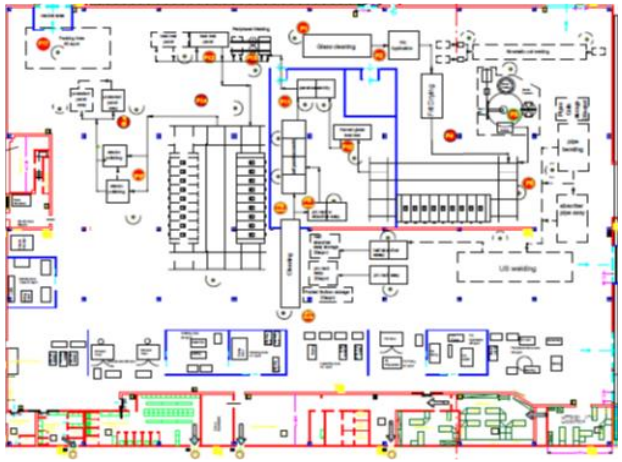
Solar air cooling	Solar desalination	Solar process heating	Solar oil processing
			
Absorption chillers 2E @ 180°C 1E @ 95°C	MED/TVC, MED &MSF 80°C to 180°C	Industrial boilers up to 180°C	GOSPs and others up to 180°C

Reference Manufacturing Module

RMM in Avellino inaugurated October 2015, production started in Q1 2016

RMM specs:

- 122’000 m^2/y nominal capacity with 5 minute takt time
- Fully automated with 35 line operators per shift
- High manufacturing yield (>92%)
- 5’000 m^2 factory surface
- Euro 7.5M equipment CAPEX
- 15 customized equipment
- 5 patented processes
- Replicable in modules



Multi-Channel Sales Strategy

1: B2B Direct Sales to Very Large Accounts

2: B2B Sales via Equipment Resellers and Consultants

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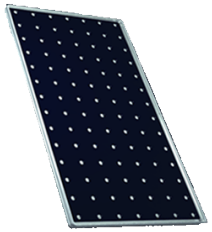

- Solar thermal solution providers
- Energy efficiency resellers & certifiers
- HVAC system integrators
- EPCs

3: B2B Sales to Energy VARs

- ESCOs/IPPs
- Utilities
- Facility Managers

4: B2B Sales via Application Machine Manufacturers

- Absorption chillers
- Boiler & dryers
- MED, MSF desalination
- ISG & OTSG

5: B2G Lobbying, Qualification to Tenders & Sales

End Client

Industry

Application		Target
	• SAC • SHIP • Desalination • District Heating • GOSP • EOR	• Oil & Gas • Food & Beverage • Pharma • Chemical • Power plants

Commercial / Service

Application		Target
	• SAC • SHIP	• Shopping malls • Warehouses • Office buildings • Datacenters • Hospitals

Housing/ Government

Application		Target
	• District cooling • District Heating • Desalination	• Gov't buildings • Universities • Water plants • Housing programs • Regulatory bodies

Dealing with Tier-1 Global Energy Players (I)

GE Global Research Munich- Germany Test for Solar Desalination June 2011	elco heating solutions Hechingen - Germany Test for Solar Space Heating July 2011	THERMAX Pune - India Test for Solar Cooling January 2012	Masdar CITY Masdar City - UAE Pilot for Solar Cooling February 2012	itw Stuttgart - Germany Test for Solar Heat Storage July 2012
LINUO Jinan- China Test for Solar Space Heating September 2012	SERIS Solar Energy Research Institute of Singapore SERIS - Singapore Test for Solar Process Heat April 2013	SIG Geneva - Switzerland Test for Solar District Heating August 2013	Life Energy Salmiya - Kuwait Test for Solar Process Heat November 2013	TATA POWER SOLAR ENABLING SOLAR EVERYWHERE Bangalore - India Test for Solar Space Heating February 2014

Dealing with Tier-1 Global Energy Players (II)

Kuwait Institute for Scientific Research	Ciemat PSA	Agility Global Integrated Logistics	TATA POWER SOLAR ENABLING SOLAR EVERYWHERE	ارامكو السعودية Saudi Aramco
KISR - Kuwait **Test for Solar Process Heat** **April 2014**	**Almeria - Spain** **Test for Solar Process Heat** **May 2014**	**Sulaibiya - Kuwait** **Test for Solar Cooling** **July 2014**	**Bangalore - India** **Test for Solar Process Heat** **July 2014**	**Damman - KSA** **Solar Field for Air-Conditioning** **October 2014**
YAZAKI	EAC Technology ENERGY AND AIR-CONDITIONING SOLUTIONS	ZONNEBOILERPRO	OCEAN RUBBER FACTORY LLC	Agility Global Integrated Logistics
Hamamatsu - Japan **Test for Solar Cooling** **February 2015**	**Vicenza - Italy** **Test for Solar Process Heat** **March 2015**	**Amsterdam - Holland** **Test for Solar Space Heating** **October 2015**	**Ras Al Khaiman - UAE** **Test for Solar Process Heat** **July 2016**	**Sulaibiya - Kuwait** **Solar Field for Air-Conditioning** **September 2016**

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ANNEX

TVP Sales Offering To Sales Partners

From panel supplier to turnkey solution provider or even EPC contractor

- Panels
- Balance of System
- Monitoring System
- Tank
- Burner
- Application Machine
- Installation
- Engineering
- Maintenance
- Reporting
- Energy Billing
- Project Financing

1) Panel supplier (in m^2)

- ✓ Panel & connectors supply
- ✓ Monitoring system supply (solar array)
- ✓ BoS recommendation
- ✓ Tank recommendation
- ✓ installation compliance check in-field
- ✓ preliminary engineering (panel array)

2) Solar Field supplier (in MW_{th})

- ✓ Panel & BoS supply
- ✓ Monitoring sys. supply (up to appl. machine)
- ✓ Tank & Burner supply
- ✓ Application machine recommendation
- ✓ installation (via local subcontractor) – opt.
- ✓ executive engineering (solar field)
- ✓ maintenance (solar field) – opt.
- ✓ energy reporting (up to appl. machine) – opt.

3) Turnkey Application Provider (in MW)

- ✓ Panel & BoS supply
- ✓ Monitoring sys. supply (system)
- ✓ Tank & Burner supply
- ✓ Application machine supply
- ✓ installation (system)
- ✓ executive engineering (system)
- ✓ maintenance (system) – opt.
- ✓ energy reporting (system) – opt.

4) ESCO (in MW_e)

- ✓ Panel, connectors & BoS supply
- ✓ BoS supply
- ✓ Monitoring sys. supply (system)
- ✓ Tank & Burner supply
- ✓ Application machine supply
- ✓ installation (system)
- ✓ executive engineering (system)
- ✓ maintenance (system)
- ✓ energy billing
- ✓ energy and economic reporting
- ✓ project financing

* Revenue items are underlined

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Solar Assisted Air Conditioning

Driving double stage absorption chiller up to 180°C

Large scale commercial & industrial buildings
End-client site deployment, custom size & configuration

District cooling
Centralized deployment, with single cooling plant remotely serving multiple end-clients

Housing programs
Single developer offering standardized solutions for individual or multiple scale, end-user deployments

- ✓ Highest peak efficiency: up to 78% sun-to-cool @ 180°C to serve double stage absorption chillers
- ✓ Highest yearly average production: due to maximum diffuse light capture
- ✓ Optionally providing year-round dual savings: *summer cooling, winter heating (with sanitary hot water for free)*
- ✓ Compact stationary solar field with minimum footprint, adaptable to any rooftop
- ✓ Reliable energy output: stabilized cost of thermal energy over lifetime of panel, vs. varying utility prices
- ✓ Off-grid autonomy: suited for uses outside of urban areas and combustible/electrical delivery grids
- ✓ Superior design for solar fields: minimizes footprint and balance of system, as well as easing installation

Solar Assisted Heat for Industrial Processes

From 80°C to 180°C heating or up to 13 bar steam indirect generation

Boilers

Steam Machines

Drying Machines

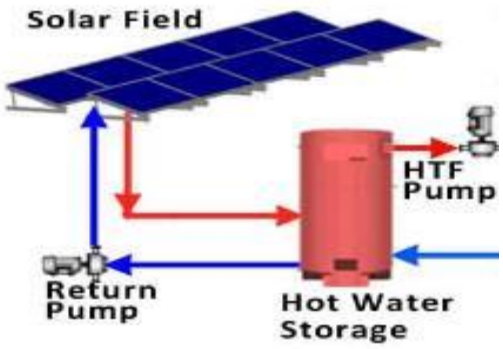
TVP target industries include:

Pharmaceuticals
Textiles
Food & Beverage
Oil & Gas
Chemical
Pulp & Paper
Hospitals
Industrial Laundry

- ✓ Independent add-on: no impact to existing thermal system infrastructure
- ✓ Highest peak efficiency: from 730 W/m^2 @ 80°C to 500 W/m^2 at 180°C
- ✓ Highest yearly average production: due to maximum diffuse light capture
- ✓ Savings on combustibles & utility bill: reduces fossil fuel dependency, related costs and CO2 produced
- ✓ Reliable energy output: stabilized cost of thermal energy over lifetime of panel, vs. varying utility prices
- ✓ Off-grid autonomy: ideal for users in remote areas and off-grid

Solar Assisted Thermal Desalination

Retrofit existing thermal desal capacity & integrate new, high GOR (up to 16) machinery



Multi Stage Flash (MSF)
Steam requirement: up to 110°C

Multi Effect Distillation (MED)
Steam requirement: up to 80°C

MED Thermo Vacuum Compressor (TVC)
Steam requirement: up to 180°C

Solar Thermal Desalination

Unique For:
High purity water
Off-grid & remote

Best For:
Coastal
Desert

Suitable for:
Potabilization

- ✓ Highest peak efficiency: up to 65% sun-to-thermal @ 160°C to serve MED/TVC desalination machines
- ✓ High daily production rate: 0.3 tonne distilled water per day per m^2 of TVP panels with GOR 14 MED/TVC
- ✓ Lowest thermal need: 48 kWhth per tonne distilled water with GOR 14 MED/TVC
- ✓ Lowest electricity need: 1 kWhel per tonne distilled water (not including seawater pump) with MED/TVC
- ✓ Off-grid autonomy: ideal for users with unstable or non-existent electricity grids
- ✓ Unique for high-purity industrial use water: <4 ppm residual total dissolved solids (TDS)

Winner: InterSolar Award 2012, Munich (DE)

Best Solar Thermal Product in 2012 for the MT-Power Panel

Winner: WIPO Innovative Enterprise 2012, Geneva (CH)

Best Patents Applied to Sustainable Development, by World Intellectual Property Org.

WIPO
WORLD
INTELLECTUAL PROPERTY
ORGANIZATION

Winner: Saint-Gobain Nova Award 2009, Paris (FR)

Best Technology Applied to Renewable Energy Due to the Glass-Metal Seal Innovation

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