Partnership

StoreLight

Photoelectrodes that store light energy

Politecnico di Torino

1859

FuncNano

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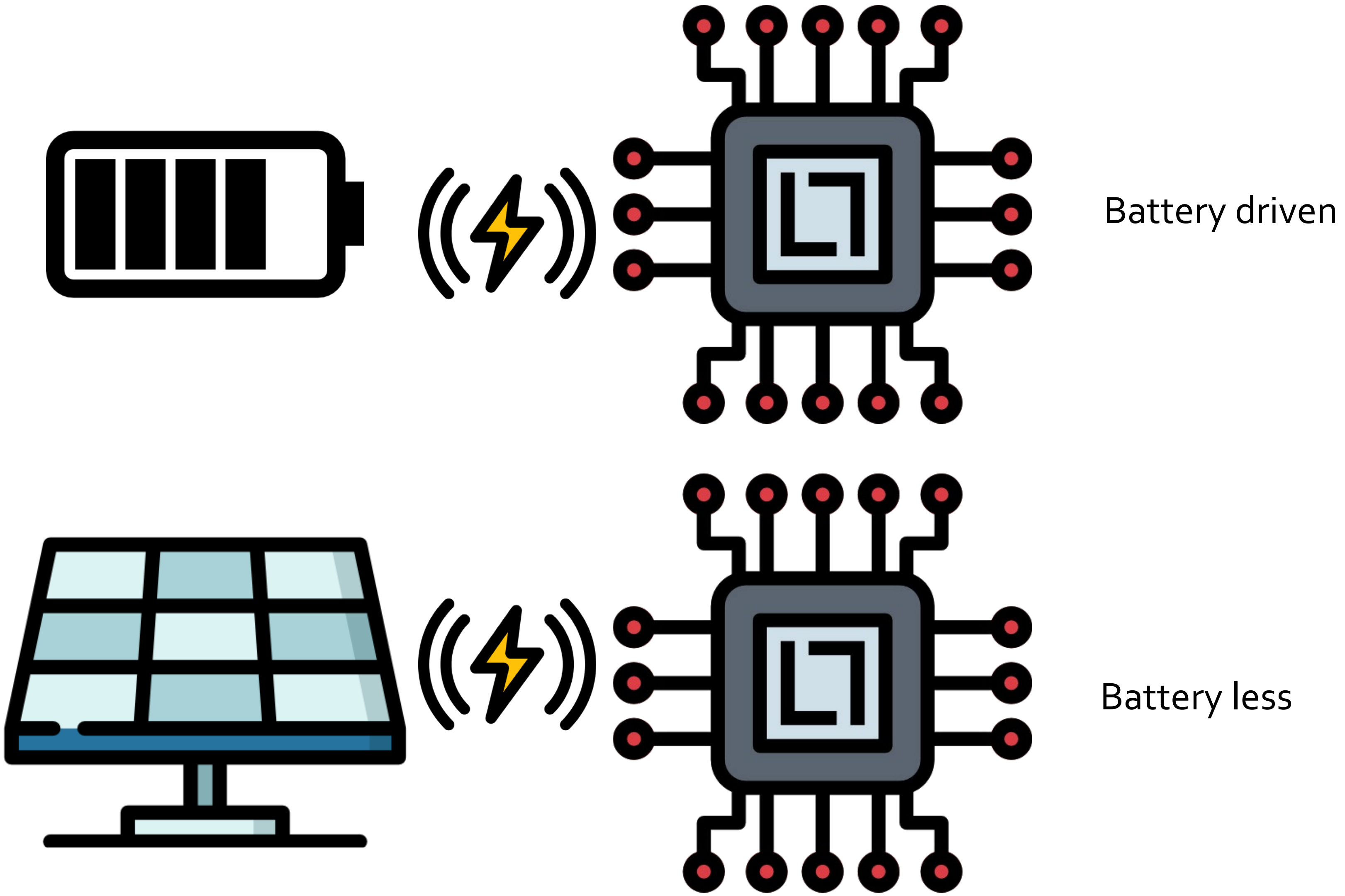
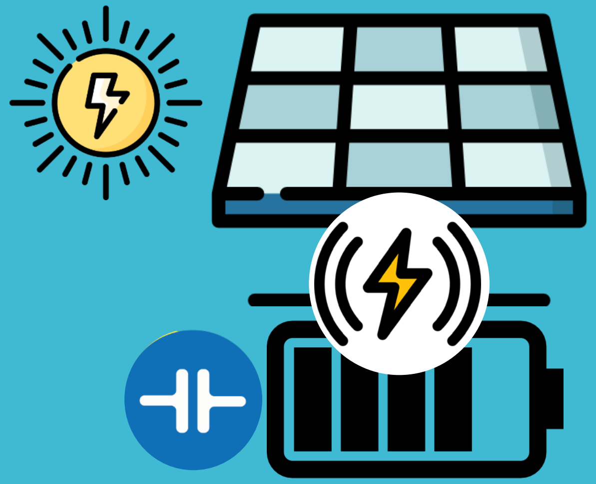
store light

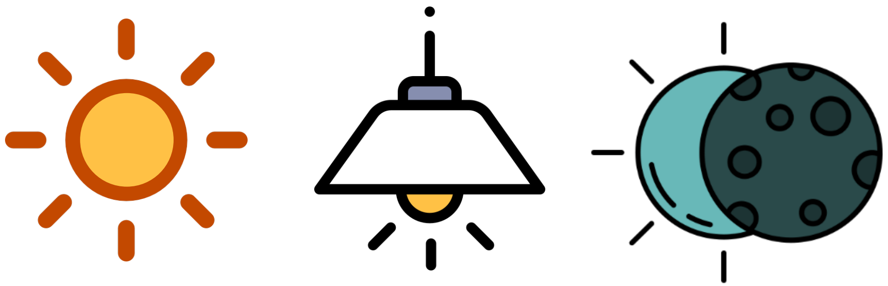
Battery or NoBattery

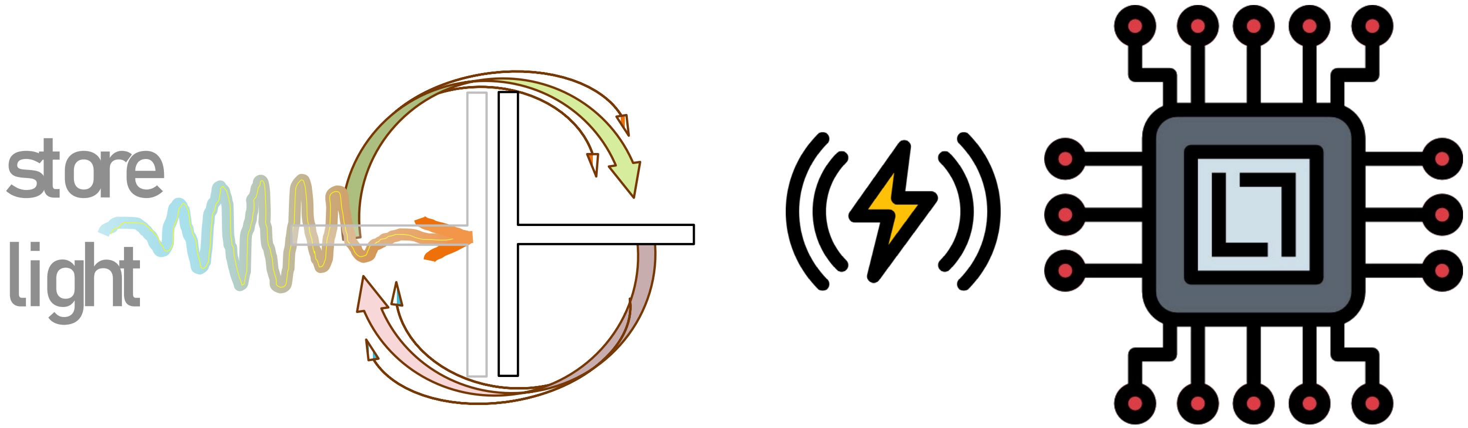


COMBINATION OF ENERGY CONVERSION AND STORAGE IN A SINGLE DEVICE

StoreLight innovation

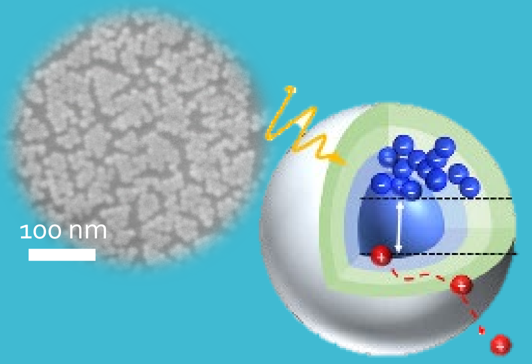




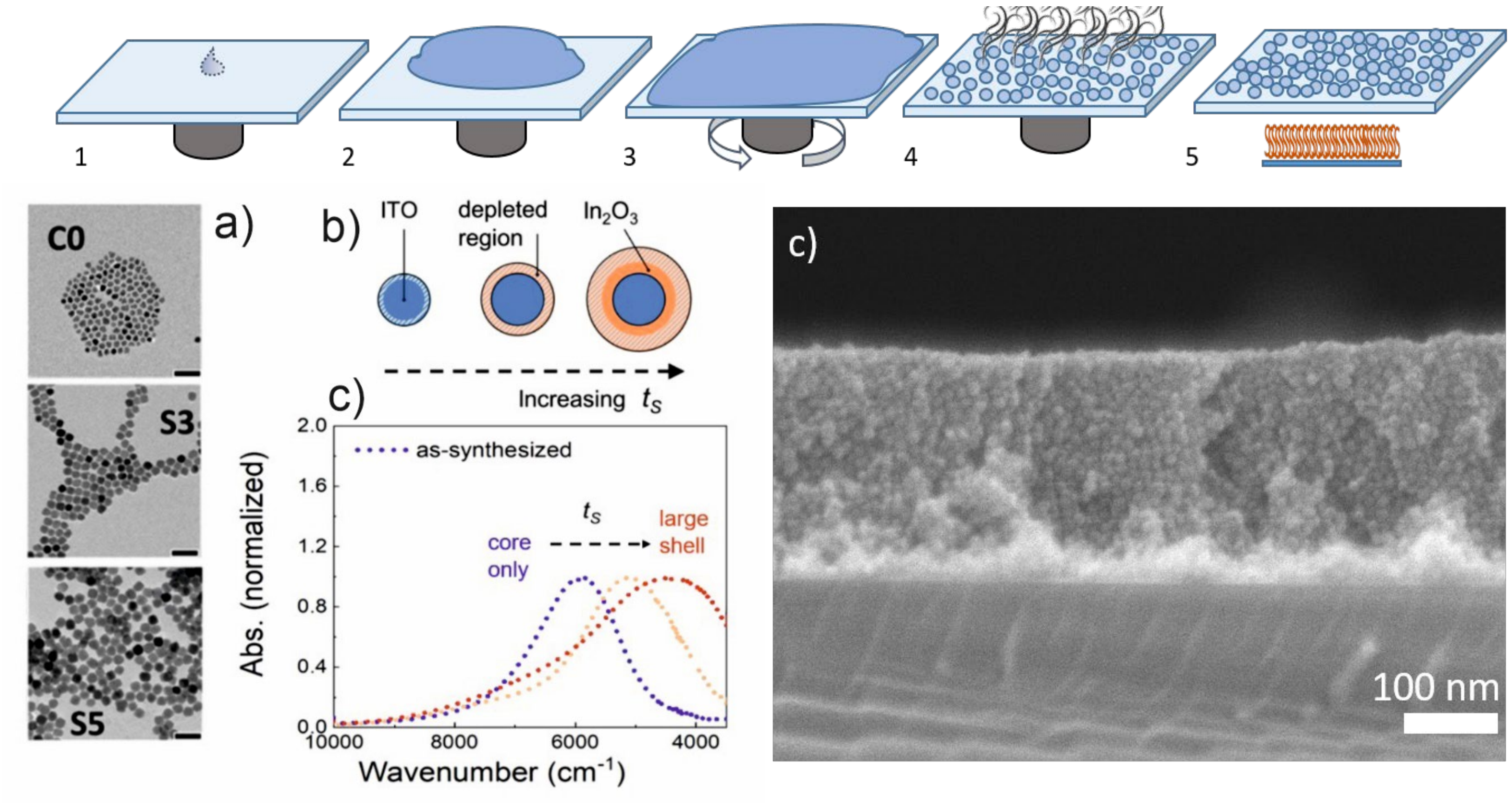


USING
OUTDOOR
AND INDOOR
LIGHT ENERGY

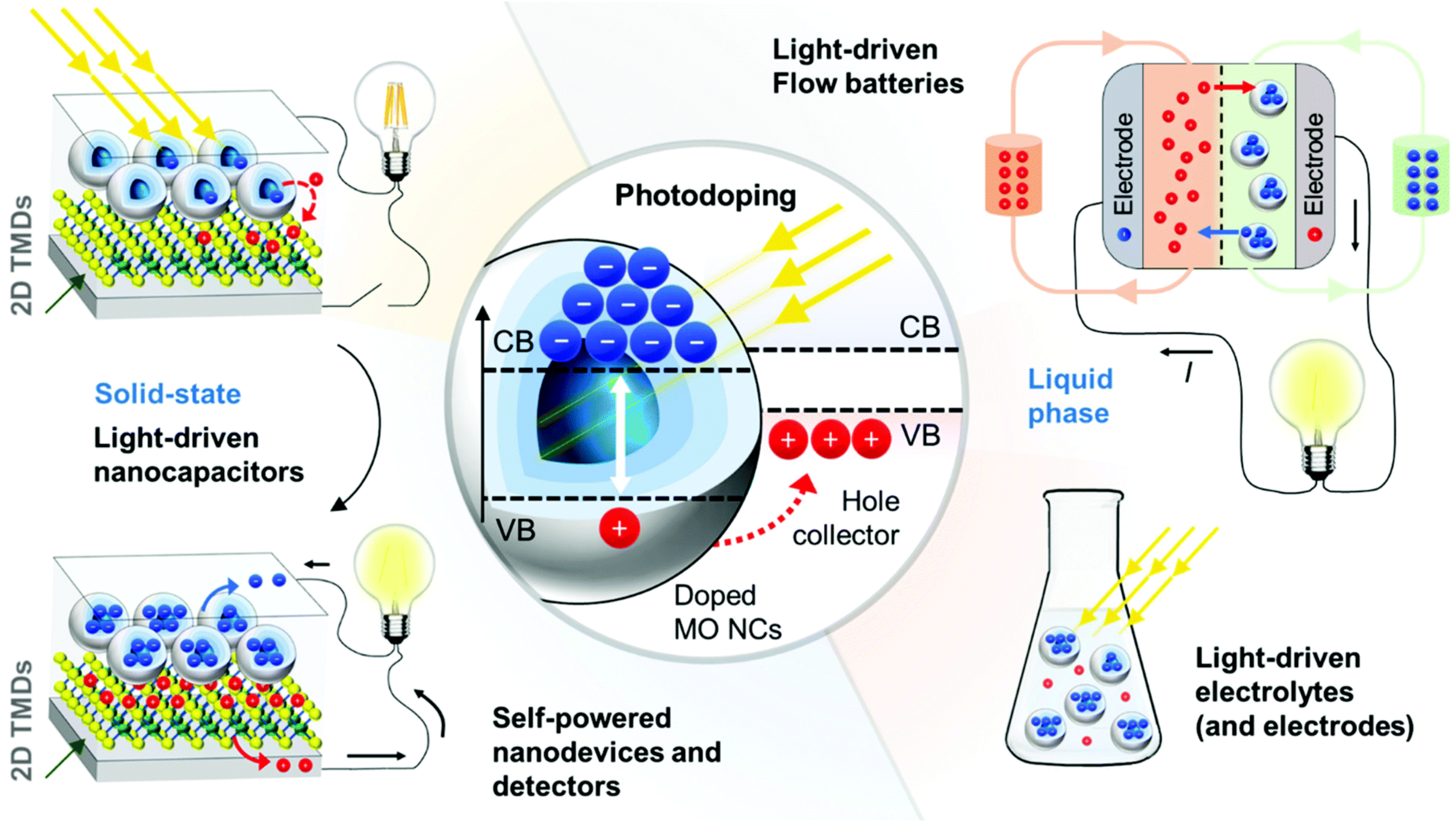
StoreLight innovation



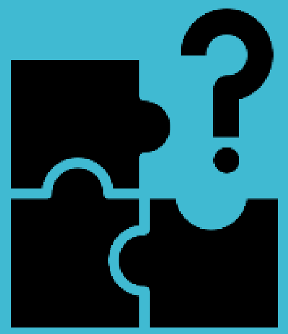
Doped metal oxide nanocrystals

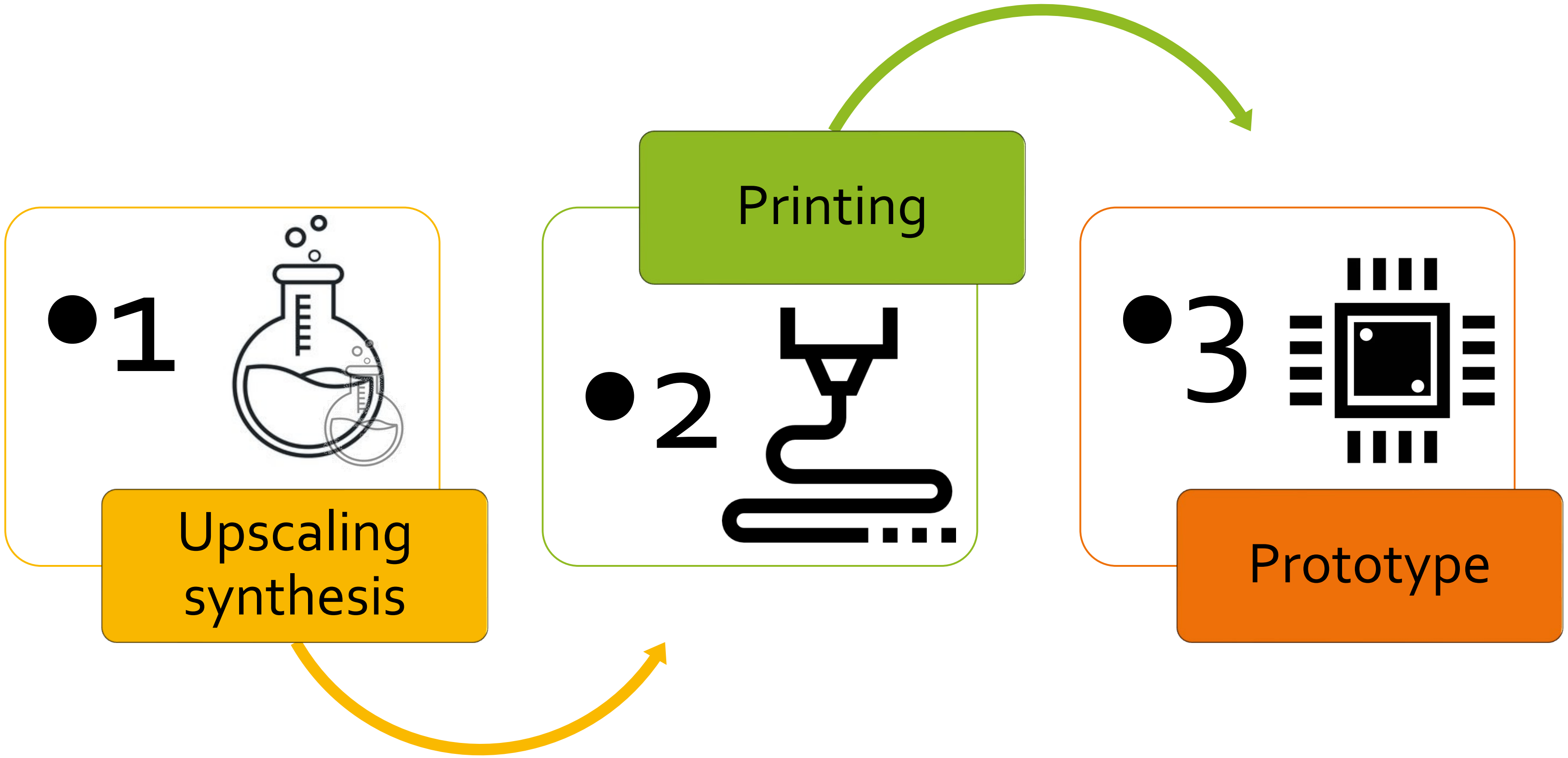


StoreLight innovation

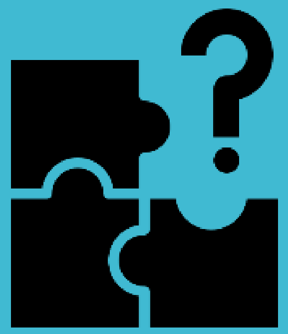


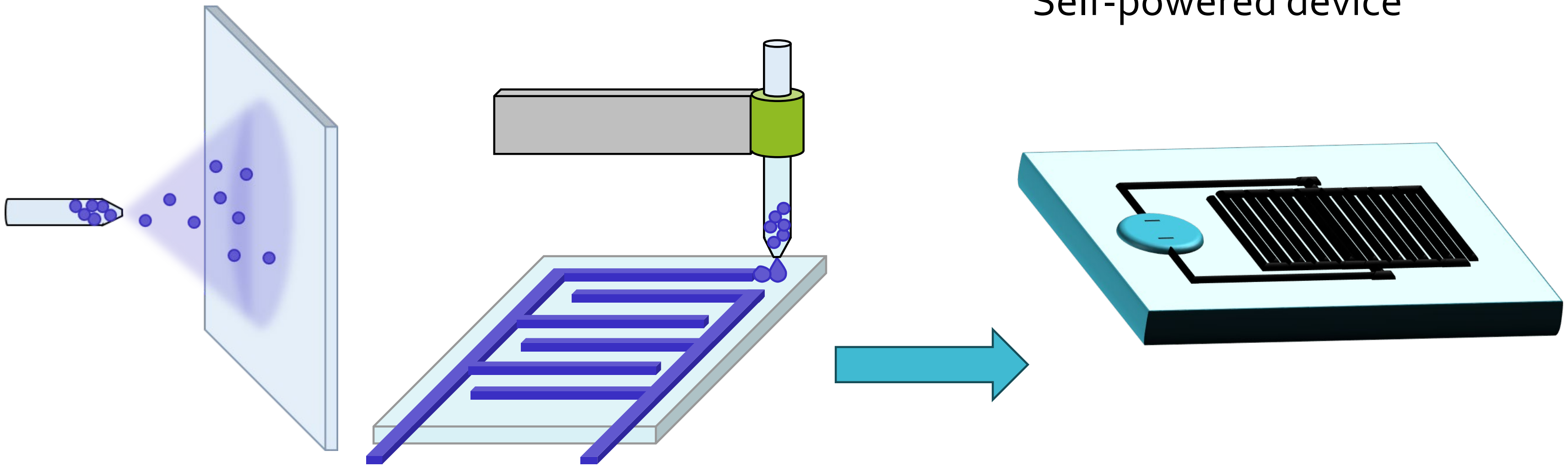
StoreLight proposition





StoreLight proposition





StoreLight team

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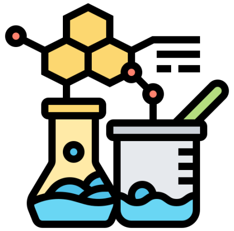

Expertise in:

Materials preparation

Advanced Characterization

Proof of concept devices

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THANK YOU FOR YOUR ATTENTION

StoreLight

Photoelectrodes that store light energy

Pulsed solar-pumped Ce:Nd:YAG lasers for efficient and rapid hydrogen extraction from aqueous ammonia under ambient condition without catalyst (SOLAR-LASER4H2)

(A04-Dawei Liang)

Dawei Liang, (Associate Professor with Habilitation), Physics Department, New University of Lisbon)
dl@fct.unl.pt

The state-of-the-art of H_2 extraction from aqueous ammonia

As a good carrier of hydrogen, ammonia–water has been employed to extract hydrogen in many ways. In 2024, Yan *et al.* reported a simple, ultrafast, and highly efficient method for hydrogen extraction from ammonia–water by laser bubbling in liquids (LBL) at room temperature and ambient pressure without catalyst. A maximum apparent yield of **33.7 mmol/h** was realizd, which were far higher than the yields of most hydrogen evolution reactions from ammonia–water under ambient conditions. In their abstract, Yan *et al.* stated that their low efficiency pulsed lamp-pumped laser used in the article (less than 0.5%) can serve as a demonstration of potentially solar-pumped catalyst-free hydrogen extraction and other chemical synthesis. Consequently, they anticipated that the LBL technique will open unprecedented opportunities to produce chemicals.

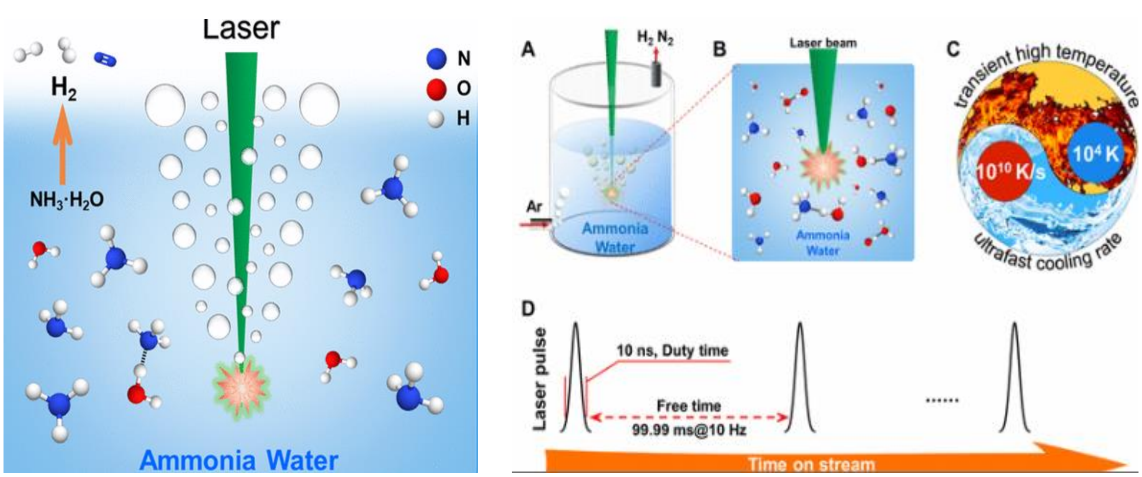
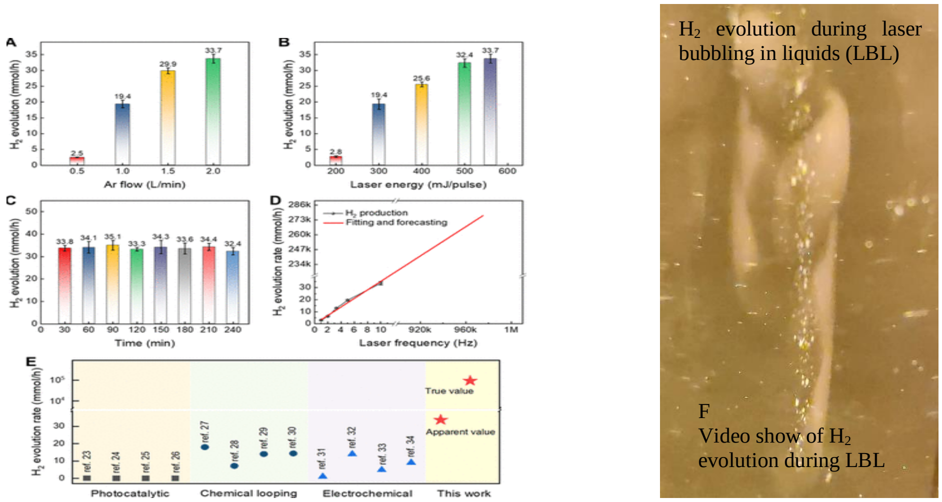


Fig. 1. Schematic illustration of Yan et al.´s experimental setup and LBL processing. Schematic of the setup for hydrogen evolution by the LBL technique. Diagram of the laser acting on the ammonia–water. When the laser was applied to ammonia–water, the molecules at the focus point were excited and ionized to produce cavitation bubbles with abundant energetic and active particles inside. These active particles inside the bubbles interacted with each other rapidly to produce hydrogen.



https://pubs.acs.org/doi/suppl/10.1021/jacs.3c13459/suppl_file/ja3c13459_si_002.mp4

Fig. 2. Measurements and calculations of hydrogen evolution rates. (A) Yields of hydrogen versus different argon flow rates at a laser energy of 560 mJ/pulse. (B) Yields of hydrogen versus different laser energies. (C) Stability of hydrogen evolution during LBL processing. (D) Effect of the laser frequency on the hydrogen yields. The laser energy was 560 mJ $pulse^{-1}$. (E) Comparison of the hydrogen yield from ammonia–water observed in this work with other methods: photocatalytic, chemical looping, and electrochemical methods. (F) **Video show of hydrogen evolution during LBL by a lamp-pumped Nd:YAG pulsed laser by Yan *et al.***

Most importantly, in their conclusion section, Yan *et al.* [1] pointed out that in terms of energy consumption, solar-pumped laser systems can be considered comparable to established systems wherein solar cells convert solar light into electricity, which is then employed for electrochemical preparation.

An example of commercial electrolysers

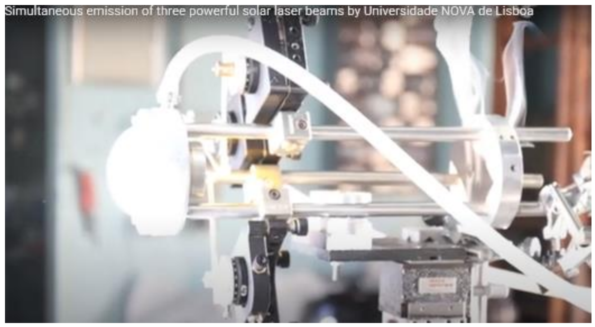
A Bosch PEM electrolysis stack is capable of producing 23 kilograms of H_2 per hour, for 1.25 Megawatts electrical input power. In another words, with the most advanced mulijunction PV module with 40% efficiency, the Bosch PEM electrolysis stack can produce 23 kilograms of H_2 per hour, for 3.125 Megawatts free solar input power. https://www.bosch-hydrogen-energy.com/electrolysis/

Bosch PEM electrolysis stack

Fig.3 For our case, for 1.73 m^2 solar energy collection area, 1000 W/m^2 solar irradiance, and 40% multijunction PV module efficiency, 0.692 kW electric power can be generated and then used to power a small BOSCH electrolysis stack, **12.73** gram of H_2 per hour yield can be calculated (0.692 kW/1250 kW × 23 kg/h =12.73 g/h).

NOVA University of Lisbon SOLAR LASER research team occupies a unique and most advantageous position for this proposal

The solar laser team of the Physics Department of NOVA University produces the most efficient solar lasers.



https://www.youtube.com/watch?v=Eq9n5MCDHjM

Fig. 4 Simultaneous emission of three powerful solar laser beams in 2022, NOVA University of Lisbon

In the above video, we reported the most efficient simultaneous emissions of three continuous-wave 1064 nm solar laser beams in Oct. 2022 [2]. For 356 W incoming solar power, 16.5 W continuous-wave total multimode solar laser power was measured, corresponding to 4.64% solar-to-laser conversion efficiency, 41.25 W/m^2 collection efficiency, and 7.64% slope efficiency, which are 1.24, 1.27, and 1.14 times, respectively, higher than previous records.

Source: Solar Energy Materials and Solar Cells 246, 111921, October 2022
DOI: 10.1016/j.solmat.2022.111921

Our solar laser research was considered as an important milestone. It has been cited 33 times in a little more than one year and was highlighted by Senior Editor Sally Johnson in

LASER FOCUS WORLD Oct. 4th 2022

"Solar pumping converts broadband sunlight into efficient laser light"
A novel three Ce:Nd:YAG rod solar-pumped laser achieves 4.64% solar-to-laser energy conversion efficiency
https://www.laserfocusworld.com/lasers-sources/article/14283698/solar-pumping-converts-broadband-sunlight-into-efficient-laser-light

Pulsed solar-pumped Ce:Nd:YAG lasers for efficient and rapid hydrogen extraction from aqueous ammonia under ambient condition without catalyst (SOLAR-LASER4H2)

Dawei Liang, (Associate Professor with Habilitation), Physics Department, New University of Lisbon) dl@fct.unl.pt

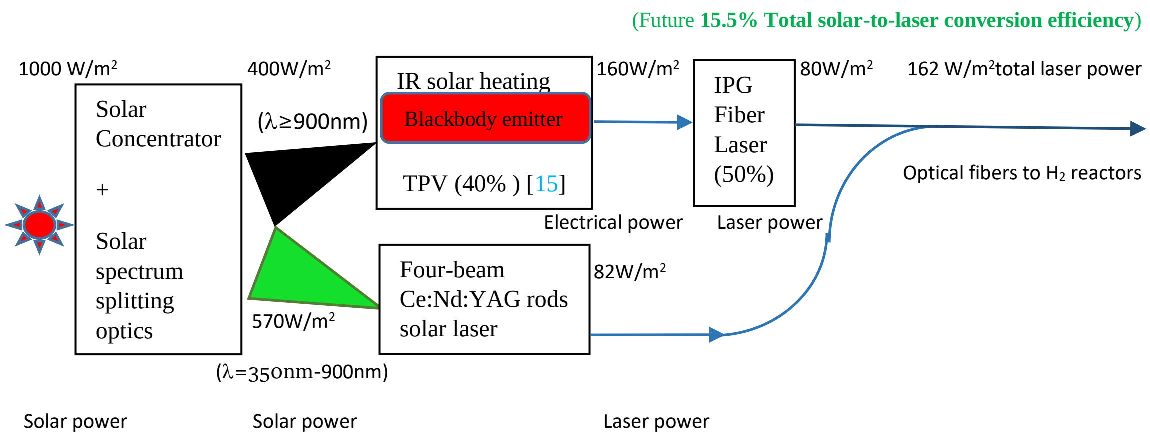


Fig. 5 Breakthrough in solar-to-laser conversion efficiency may be attained by the simultaneous laser emissions from both a Ce:Nd:YAG solar laser and a fiber laser powered by electricity generated by a blackbody emitter thermal PV device, envisaging a bright future for the most rapid extraction of H_2 from ammonia-water, and consequently future installation of *in situ* H_2 fuel-cell vehicle charging stations.

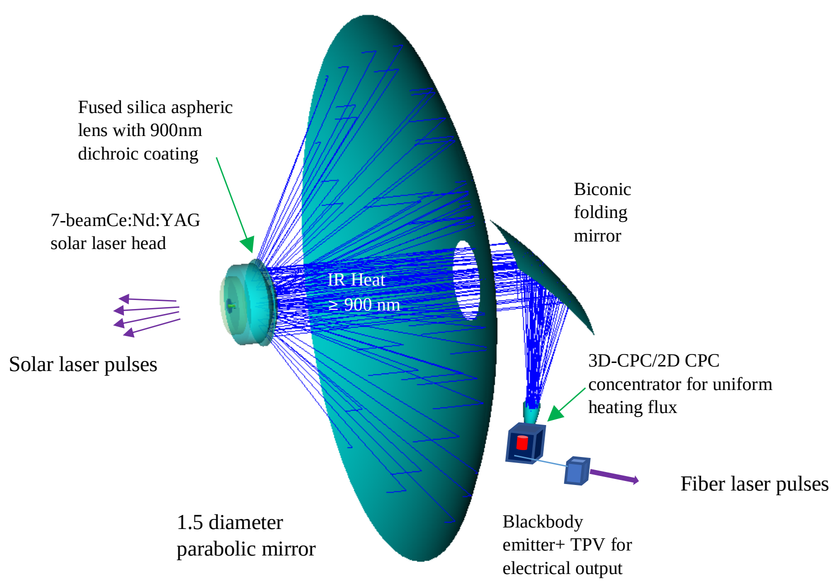


Fig. 6 IR heat above 900 nm can be reflected, via a central hole of the 1.5 m parabolic mirror and a biconic folding mirror to the 3D-CPC/2D-CPC concentrator for the uniform heating of the blackbody emitter. The heat load of a graphite emitter was successfully calculated at the exit of the 2D-CPC.

Zemax and LASCAD optimization of multimode, TEM_{00}-mode solar laser power, M2 factors, and thermal effects of the seven Ce:Nd:YAG rods

Fig. 7 Laser pulses from the 2 solar laser heads, with several hundred mJ pulse energy, at 50 Hz repetition rate, can be efficiently coupled to 7 H_2 reactors by 7 optical fibers.

Coupling laser pulses to H_2 reactors

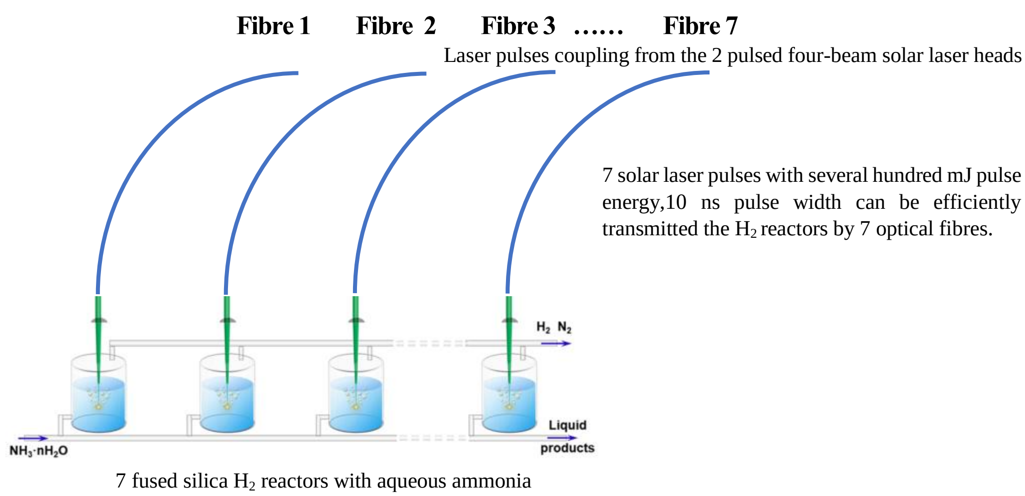


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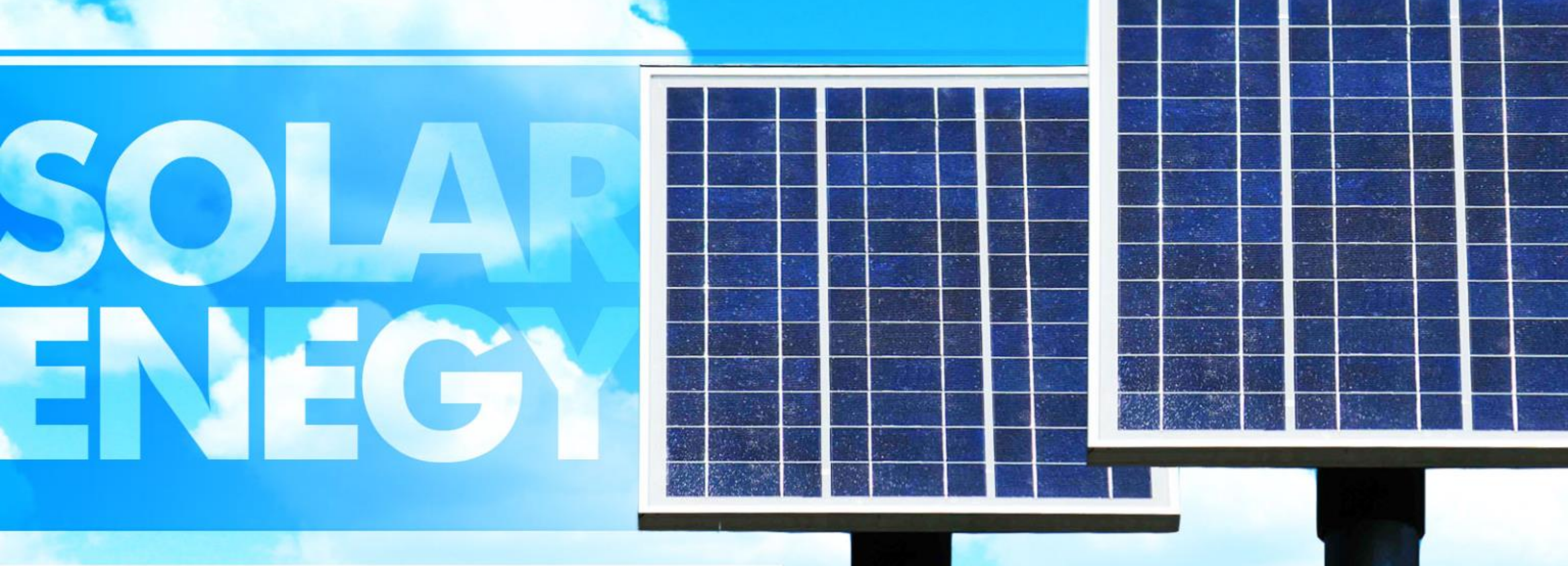
Fig. 8 By using 7 optical fibres, 7 series of powerful Ce:Nd:YAG solar laser pulses can be transmitted from the Ce:Nd:YAG solar laser heads (in Fig. 2 and Fig. 3) to 7 H_2 aqueous ammonia reactors for the most efficient and rapid extraction of H_2

Concentrated Solar Energy through Fresnel Lens



Sri Ramnadh Mandali
CEO, Founder
Lipongroup

Introduction

- Concentrated Solar Power (CSP) is the technology developed to generate electricity by converting concentrated sunlight into solar thermal energy. Mirrors reflect solar radiation to a thermal receiver. This collected solar energy is then absorbed and used to heat the so-called heat-transfer fluid (HFT).
- The heat retained in the fluid is stored and then powers a turbine to generate electrical energy. As we are talking about a thermal energy storage (TES), this energy can be used later, during periods of low sunlight, and even at night.
- Thermal energy also can be used in several industrial applications such as food processing and water desalination.

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Difference between CSP and CPV

- The two systems may appear to be the same but each uses different technologies. Concentrator photovoltaics converts the sunlight into electricity through PV cells made of semiconductor materials.

- While the photovoltaic effect comes into play in one, the other system (CSP) uses different principles, such as the heat-transfer fluid.

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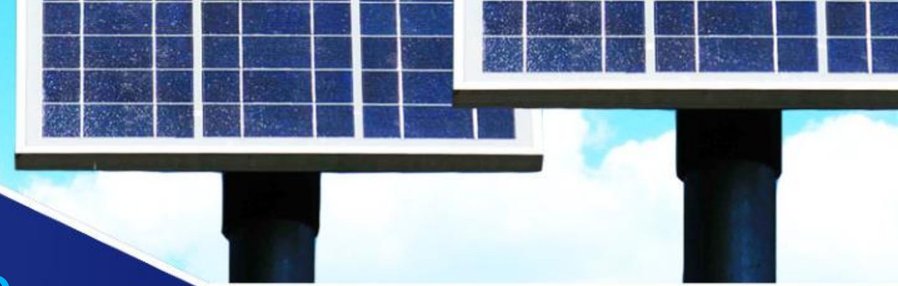

Operations & Significance

Feature	Concentrated Solar Power (CSP)	Concentrated Photovoltaics (CPV)
Working Principle	Uses mirrors/lenses to concentrate sunlight to heat fluid, producing steam to drive a turbine.	Uses lenses/mirrors to concentrate sunlight onto high-efficiency PV cells to generate electricity directly.
Energy Conversion	Sunlight → Thermal Energy → Electrical Energy	Sunlight → Electrical Energy
Components	Mirrors/Lenses, Heat Transfer Fluid, Steam Turbine, Thermal Storage	Lenses/Mirrors, High-Efficiency PV Cells, Tracking Systems
Types of Systems	Parabolic Troughs, Solar Power Towers, Linear Fresnel Reflectors, Dish Stirling Systems	Low Concentration (1-100 suns), High Concentration (>100 suns)
Advantages	Efficient thermal energy storage, power generation during non-sunny periods, high efficiency in sunny regions	Higher efficiency compared to traditional PV, reduced PV material area needed
Challenges	Requires large land areas, high initial costs, system complexity	Requires precise sun tracking, high initial costs for concentrators and tracking systems, significant efficiency drop if misaligned

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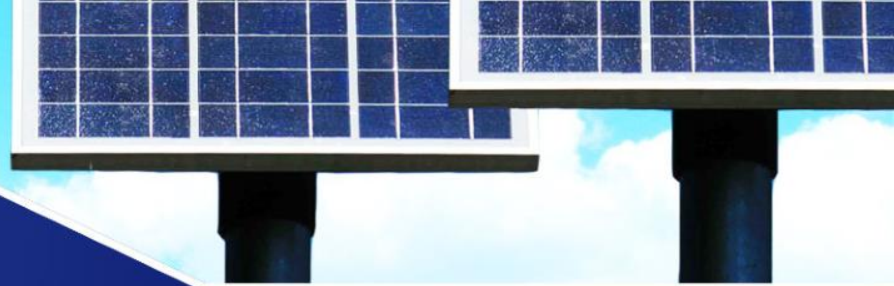
CSP Plant Efficiency

- **CSP Plants**

1. **Ivanpah Solar Power Facility (USA)**
   - **Type**: Solar Power Tower
   - **Capacity**: 392 MW
   - **Efficiency**: ~33%
2. **Crescent Dunes Solar Energy Project (USA)**
   - **Type**: Solar Power Tower
   - **Capacity**: 110 MW
   - **Efficiency**: ~34%
3. **Noor Ouarzazate Solar Complex (Morocco)**
   - **Type**: Parabolic Troughs and Solar Power Tower
   - **Capacity**: 580 MW (combined)
   - Efficiency :~35%

SOLAR ENERGY



CPV Plant Efficiency

- **SolFocus SF-1100P (Spain)**
  - **Type: High Concentration PV**
  - **Capacity: 10 MW**
  - **Efficiency: ~37%**
- **Amonix 7700 CPV (USA)**
  - **Type: High Concentration PV**
  - **Capacity: 2 MW**
  - **Efficiency: ~35%**
- **Suncore GSR-5000 (China)**
  - **Type: High Concentration PV**
  - **Capacity: 5 MW**
  - **Efficiency: ~38%**

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Drawbacks & Limitations

High Initial Costs	CSP plants require significant capital investment for construction and equipment.
Land Use	CSP systems need large areas of land, often in desert regions, which can impact local ecosystems.
Water Usage	Many CSP systems, especially those using steam turbines, require substantial amounts of water for cooling, which can be problematic in arid regions.
Complexity and Maintenance	CSP plants involve complex systems with multiple components (mirrors, heat transfer fluids, turbines) that require regular maintenance and skilled labor.
Weather Dependence	CSP efficiency can be significantly reduced by clouds, dust, or other atmospheric conditions, which affect the concentration of sunlight.
Energy Storage Costs	While thermal storage can help provide power when the sun isn't shining, it adds to the cost and complexity of the system.
Location Specificity	CSP plants are most effective in areas with high direct normal irradiance (DNI), limiting their geographical deployment.
Grid Integration	Integrating large-scale CSP plants into existing power grids can be challenging, requiring upgrades and advanced grid management.
Long Construction Times	The construction and commissioning of CSP plants can take several years, delaying the return on investment.
Environmental Impact	The large-scale development of CSP projects can lead to habitat disruption and changes in land use, impacting local wildlife and vegetation.

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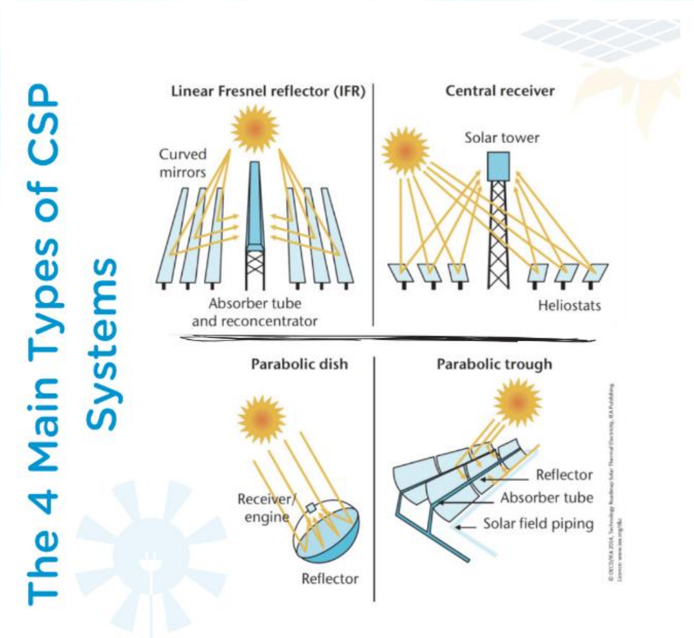
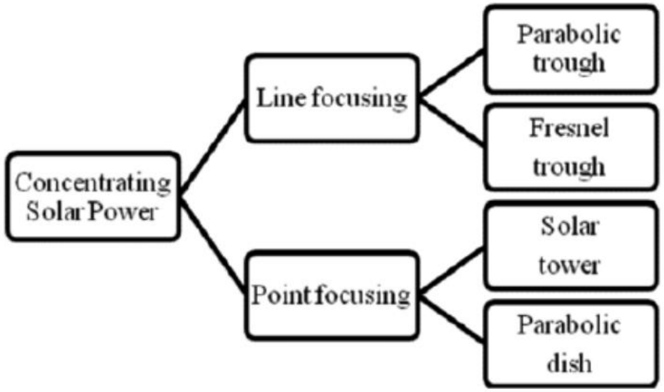
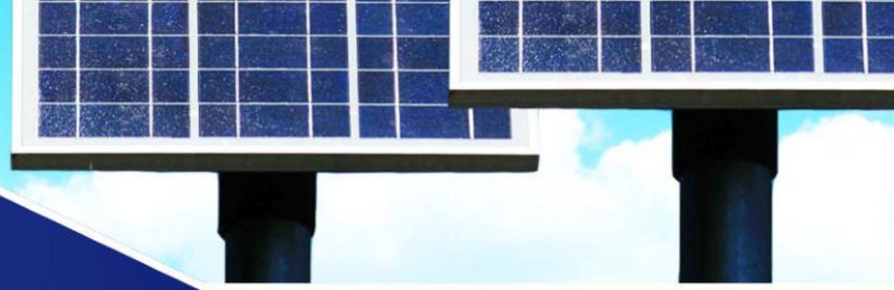
Classification







Aspect	Parabolic Troughs (Line-Focusing)	Solar Power Towers (Point-Focusing)
Design	Long, curved mirrors focus sunlight onto a receiver tube	Field of flat, movable mirrors (heliostats) focus sunlight onto a central receiver at the top of a tower
Thermal Efficiency	60-80%	80%+
Overall System Efficiency (Electricity Generation)	15-20%	20-35%
Advantages	- Mature and commercially proven technology - Can use various heat transfer fluids - Suitable for large-scale power plants	- Higher efficiency at converting thermal energy to electricity - Better suited for energy storage - Higher operating temperatures
Disadvantages	- Requires large land area - Less efficient at higher temperatures	- More complex and costly to build and maintain - Requires precise heliostat alignment and tracking
Cost	Generally lower	Generally higher
Land Use	Requires more land	More land-efficient
Energy Storage	Less suitable for high-efficiency storage due to lower operating temperatures	Better suited for energy storage due to higher operating temperatures

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Problem :CSP Efficiency

CSP has an efficiency of around **7%** and **25%**, which is very close to the results of solar photovoltaics.

HOW TO IMPROE SOLAR EFFICIENCY ?

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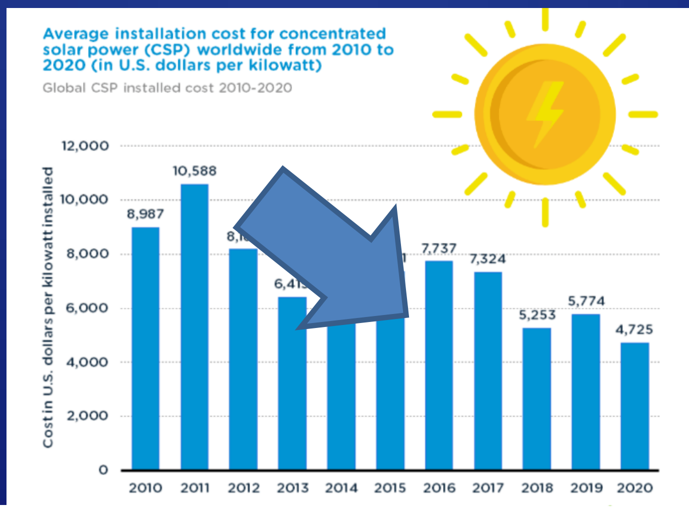
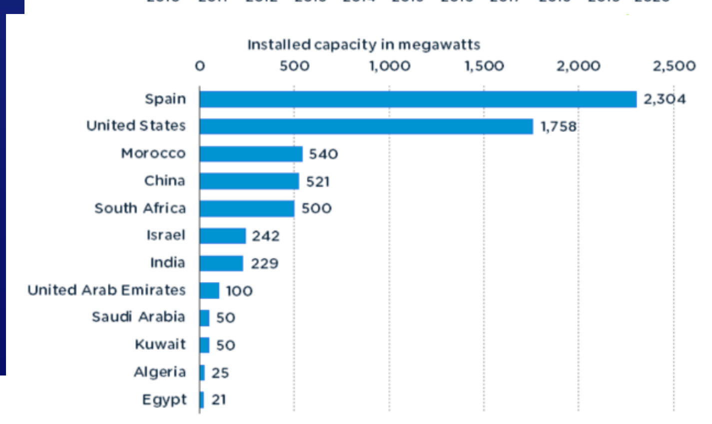
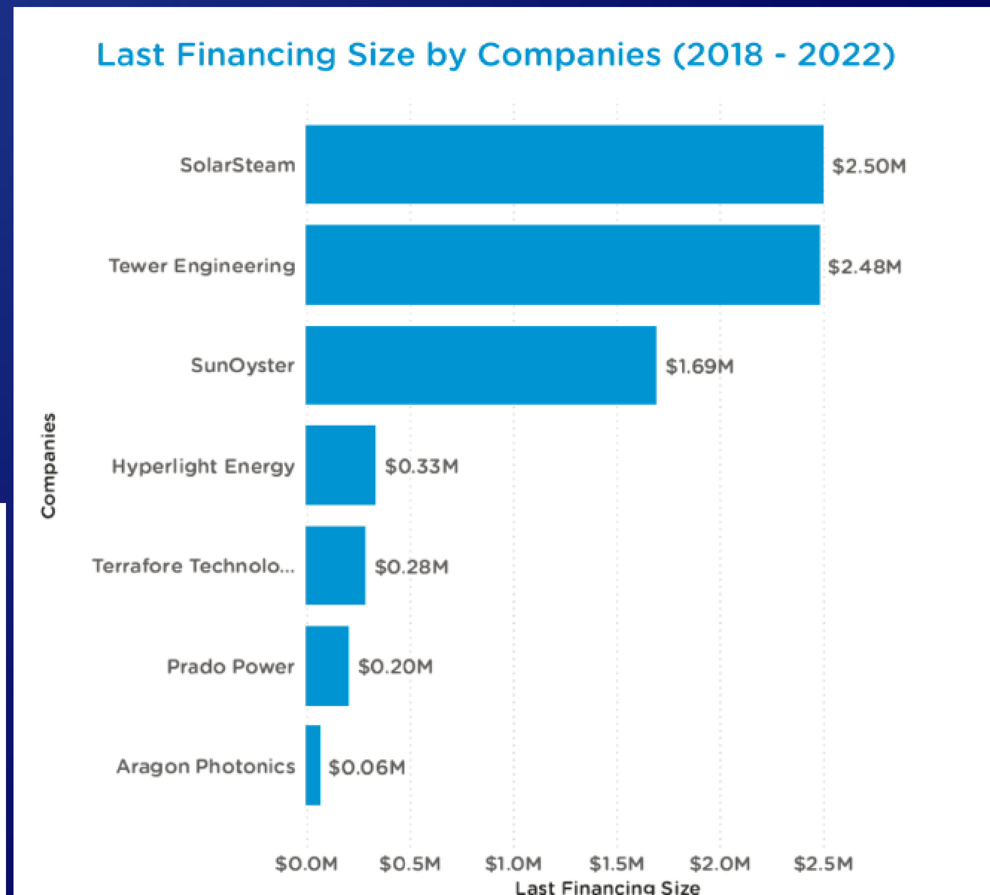
CSP – Financials : Growth Strategy







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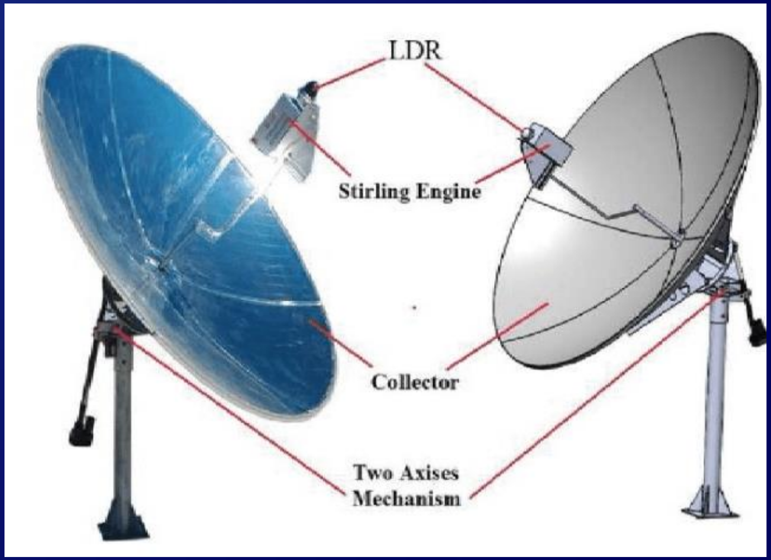
Solar Dish Stirling Engines: Hybrid Solar Technology

- Modular Hybrid Design
- Dual axis Tracking system
- Compact Design
- Cost –Effective
- High Temperature Operation
- Low maintenance
- Zero GHG emissions.



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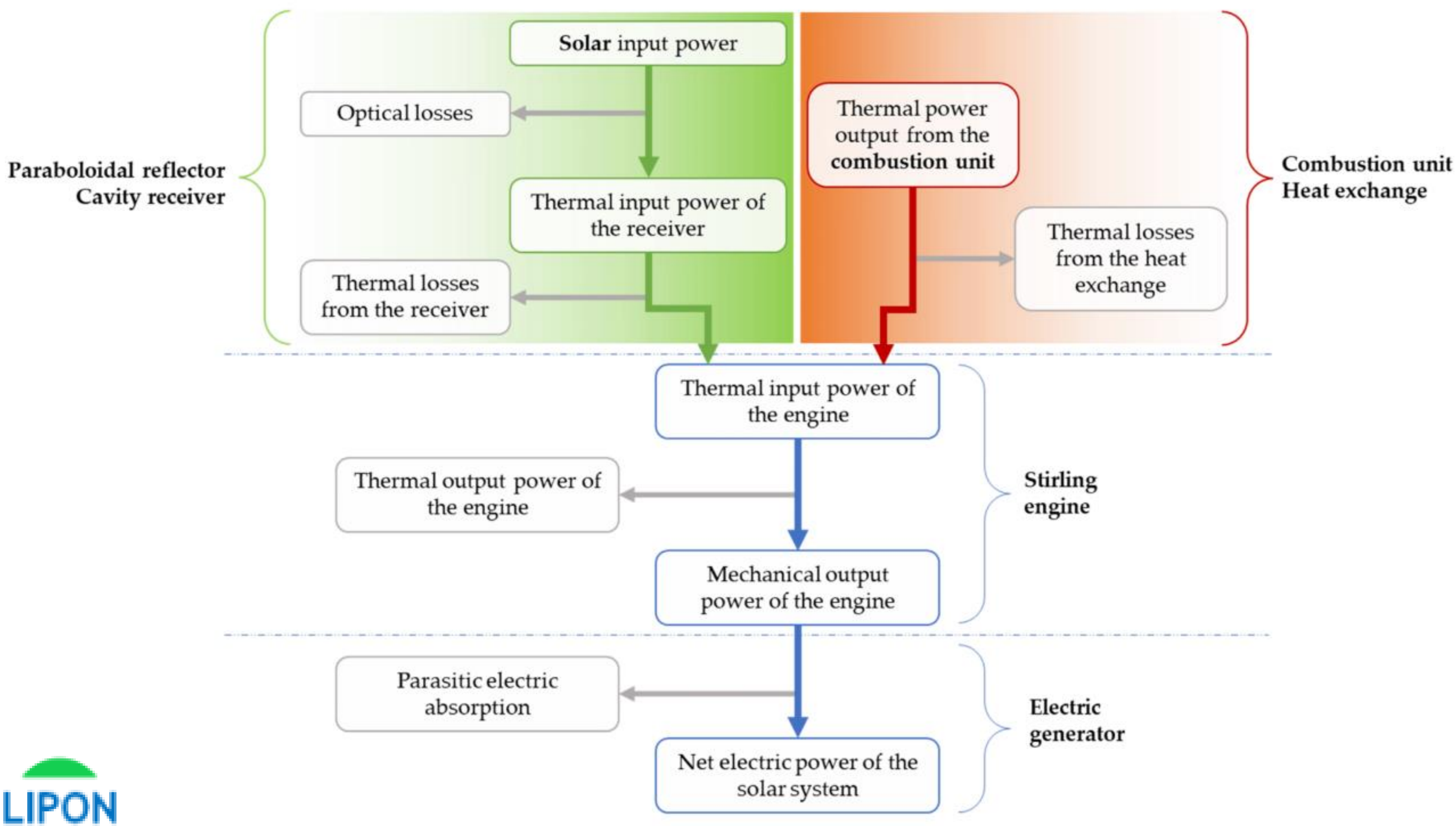
Process Flow Chart



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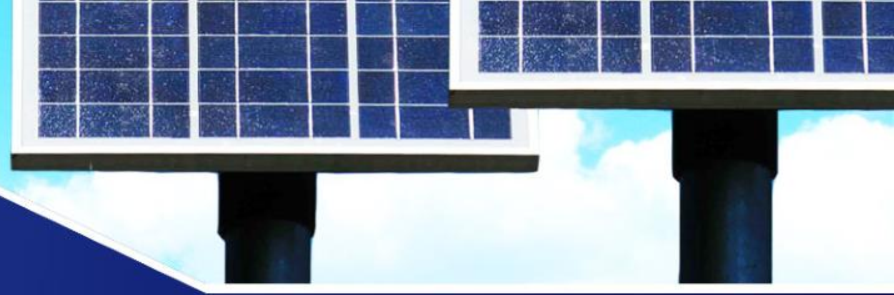
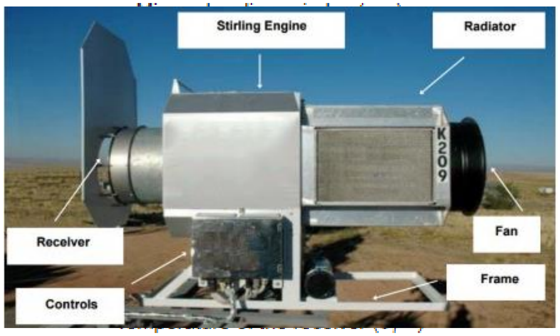


Thermal Fluid :System

Property	Hydrogen	Helium	Air	Mixtures	Oils	Molten Salts
Thermal Conductivity	Very high	High	Moderate	High	Moderate to High	High
Specific Heat Capacity	Low	Low	Moderate	Low	High	High
Flammability	Highly flammable	Non-flammable	Non-flammable	Non-flammable	Non-flammable	Non-flammable
Cost	Moderate to high	Expensive	Inexpensive	Expensive	Expensive	Expensive
Environmental Impact	Environmentally friendly	Inert	-	-	-	-
Availability	Readily available	Limited	Readily available	Limited	Limited	Limited
Thermal Stability	-	-	-	-	Good	Excellent
Handling and Storage	Requires careful handling and storage	Requires high-pressure systems	-	-	-	Requires complex handling and maintenance

Parameter
Aperture area of the receiver (A_r)
Average parasitic electric consumption $(\dot{E}_p^{ave})$
Maximum thermal input power of the engine $(\dot{Q}_{S,in}^{max})$
Clean mirror optical efficiency (η_o)
Convective heat transfer coefficient of the receiver (h_r)
Emissivity of the receiver (ε_r)
Focal length
Geometric concentration ratio
Max operating pressure of hydrogen



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Stirling Engine Configurations

Configuration	Description	Range	Fluids
Alpha	Two-chamber design with a regenerator; working gas alternately heated and cooled.	15% - 30%	Hydrogen, Helium
Beta	Two-chamber design with a displacer and power piston in a single cylinder.	20% - 35%	Hydrogen, Helium
Gamma	Two-cylinder design with separate power piston and displacer; simpler than Beta.	25% - 40%	Hydrogen, Helium
Free Piston	Pistons and displacer move freely within the cylinders, guided by gas pressure and magnetic fields.	Up to 40%	Hydrogen, Helium
Ringbom	Variation of Beta with a regenerator ring around the cylinder, reducing dead volume.	25% - 35%	Hydrogen, Helium
Multi-Cylinder	Multiple cylinders working in parallel or series, each with its own pistons and displacers.	Up to 40%	Hydrogen, Helium

Stirling Engine – Water as Fluid

Feature	Stirling Engine with Molten Salts	Stirling Engine with Saline/Fresh Water
Temperature Range	High (400°C to 1000°C)	Low to Moderate (below 200°C)
Thermal Efficiency	High	Moderate
Thermal Storage	Excellent	Limited
Corrosion Resistance	Requires corrosion-resistant materials	Requires corrosion protection in the heat exchanger
Cost	Higher due to materials and operating temperatures	Lower due to lower operating temperatures and abundant working fluids
Scale	Suitable for large-scale applications	Suitable for smaller-scale applications

Solar Dish Stirling Engines

1.5MW Demo Project @ California,USA

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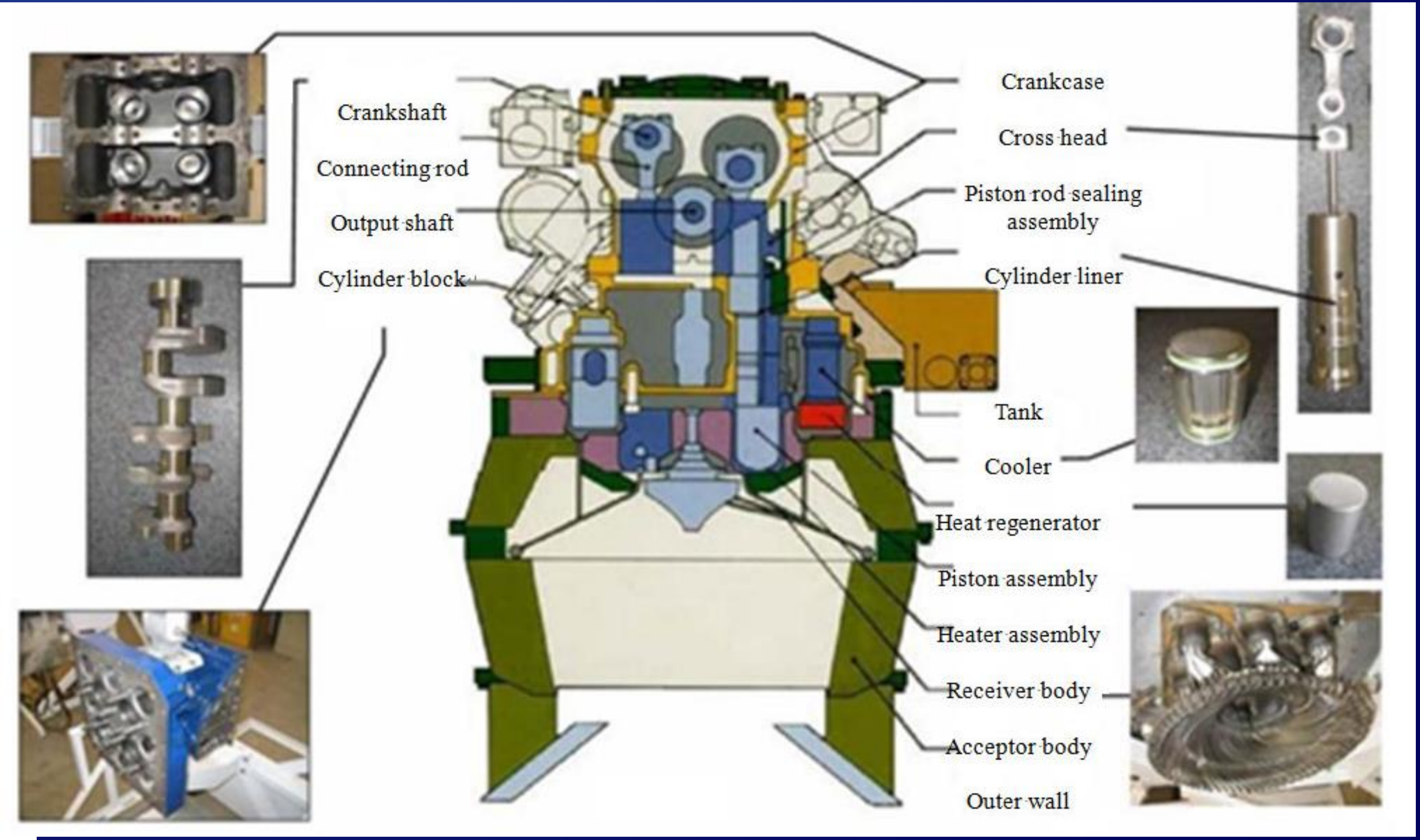
Typical Stirling engine



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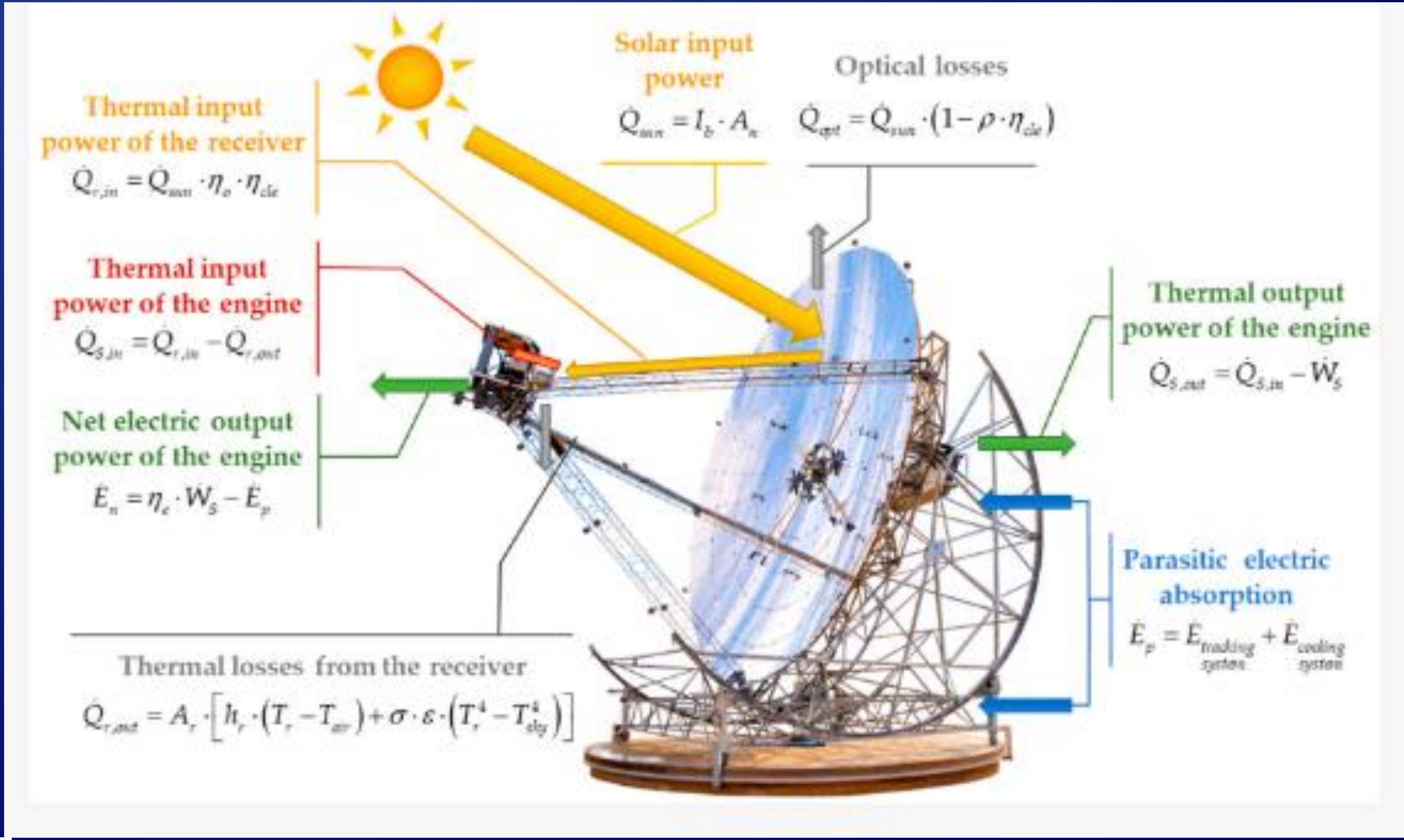
Heat Transfer : Analysis



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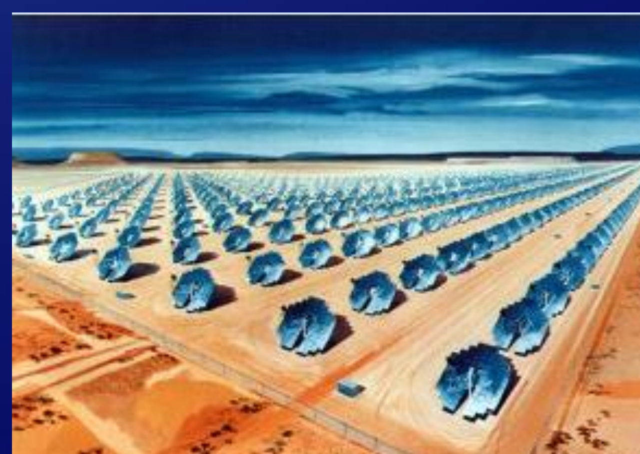
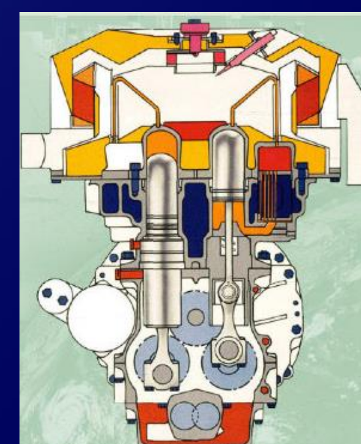
Technical specifications

- Collector: 82 facet mirror made with 0.7 mm thin glass with 87.7 m^2 area, relectivity 0.91
- Engine: Patented engine, 4 cylinder stirling engine 380 cc, working temp 720ºC (1328ºF), with variable pressure control

Rating and performance:

- Module rating: 25 kW at 1000W/m^2 solar input, Electrical: 480 v, 3 phase 50 or 60 cycle
- Module performance: Peak power 24.9 kW, peak efficiency 29.4%, Annual efficiency 24%





Collaboration & Team

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RES INSTITUTE

RENEWABLE ENERGY SYSTEMS

Blueprints for a friendly climate on earth

PSU PRINCE OF SONGKLA UNIVERSITY

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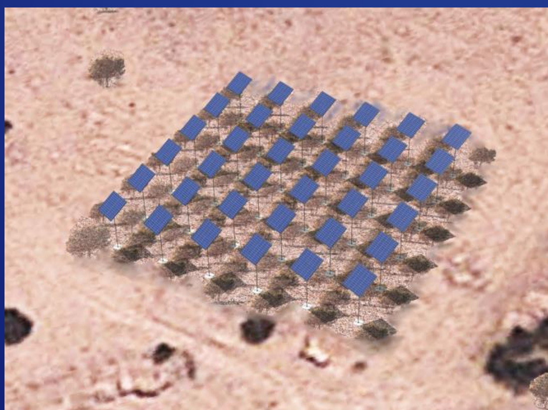
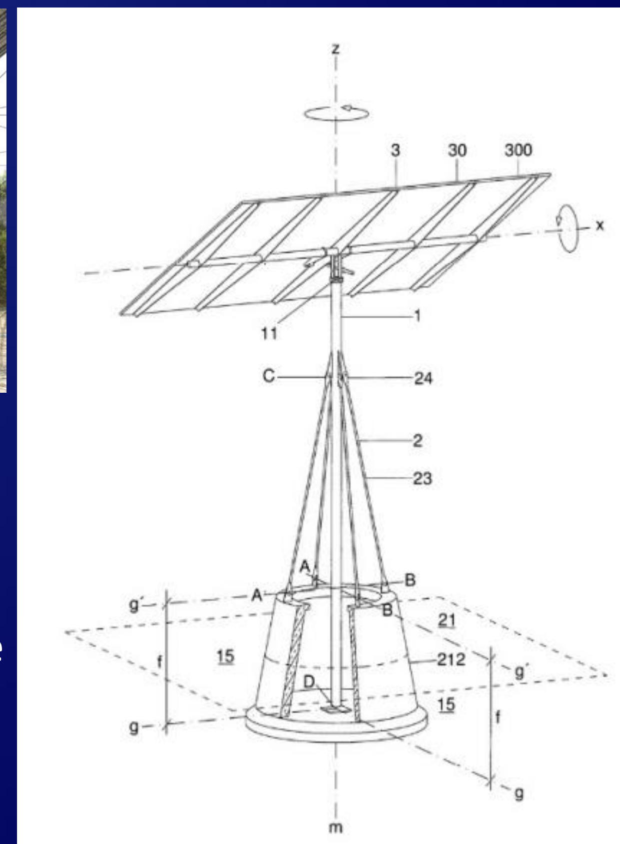
Patent & Innovation solutions



Mast type Solar PV

Mast & Elevated type Solar PV



Patented Technology
For agricultural process

The mast, which is stabilized by tension members, has a foundation body designed as a cistern. When it rains, the PV modules are moved into a horizontal position so that the rainwater can be fed through the mast into the cistern.

In this way, the raised collector surfaces enable a storage system for rainwater and thus benefit agriculture.

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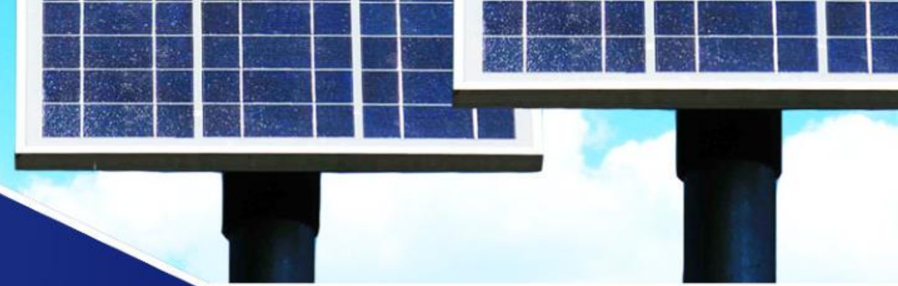
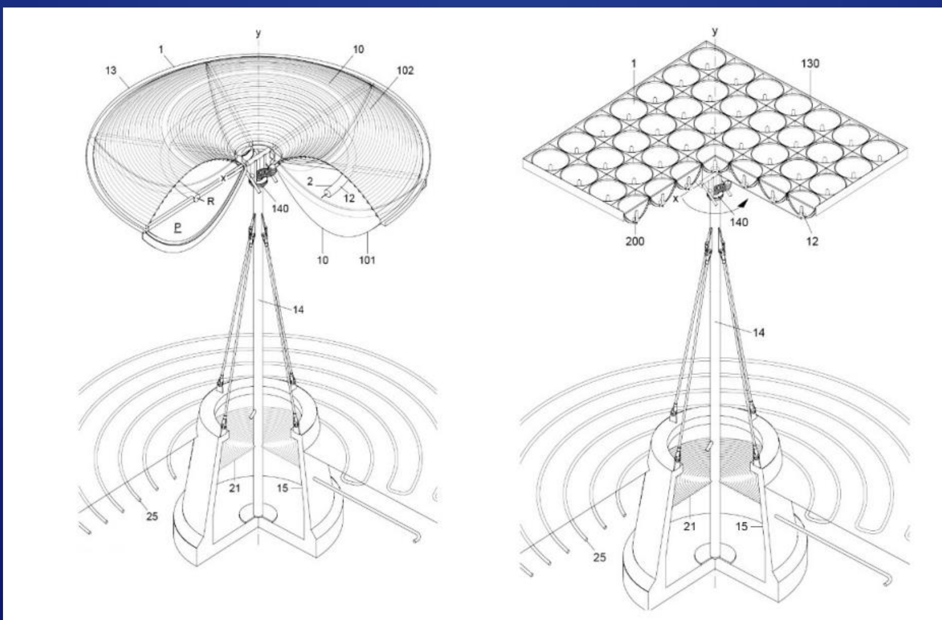


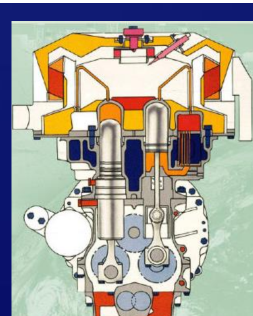
Disc Collector Design



Combining dish collectors with Fresnel mirrors and Stirling engines offers a highly efficient CSP system, potentially achieving efficiencies of 40% or more. The use of Fresnel mirrors provides precise and effective sunlight concentration, while Stirling engines efficiently convert this concentrated thermal energy into mechanical and electrical energy.

Despite the higher initial costs and the need for precise engineering and maintenance, this hybrid system is suitable for small to medium-scale installations where maximizing efficiency is crucial.

Solar Disc Collector +Stirling Engines + Water harvesting storage system



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THANK YOU

Please contact for more details

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Czestochowa University of Technology

Faculty of Mechanical Engineering and Computer Science

Passive method of turbulent flow separation control using wavy surface for offshore wind energy

Artur Dróżdż
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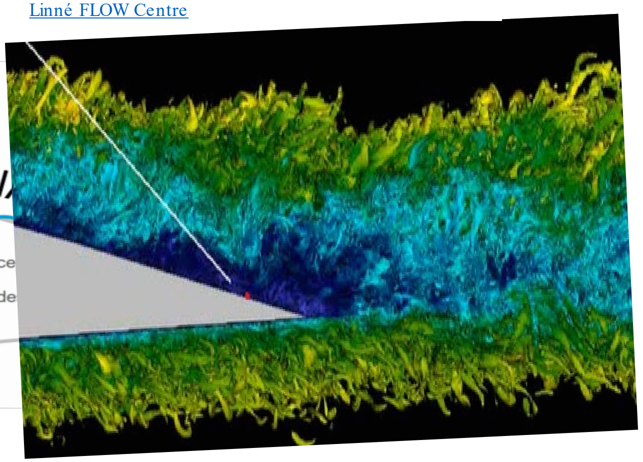
Czestochowa University of Technology, Department of Thermal Machinery al. Armii Krajowej 21, 42-200 Czestochowa, Poland

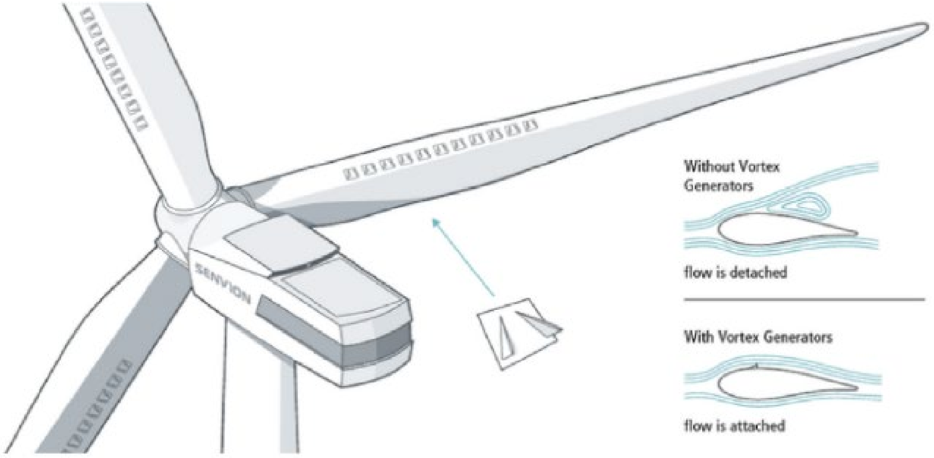
Research is devoted to implement a novel passive control method of turbulent flow separation for the longest offshore wind turbine blades

DNS Re=400000 NACA4412
Linné FLOW Centre



How it works? (better than vortex generators?)

- **based on physical mechanism occurring in turbulent flow (so-called amplitude modulation)**
- **It postpone turbulent flow separation**



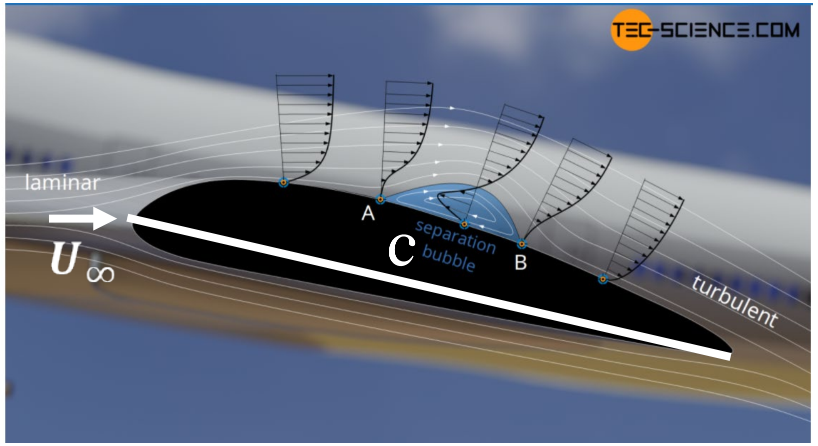
It is all about the Reynolds number!

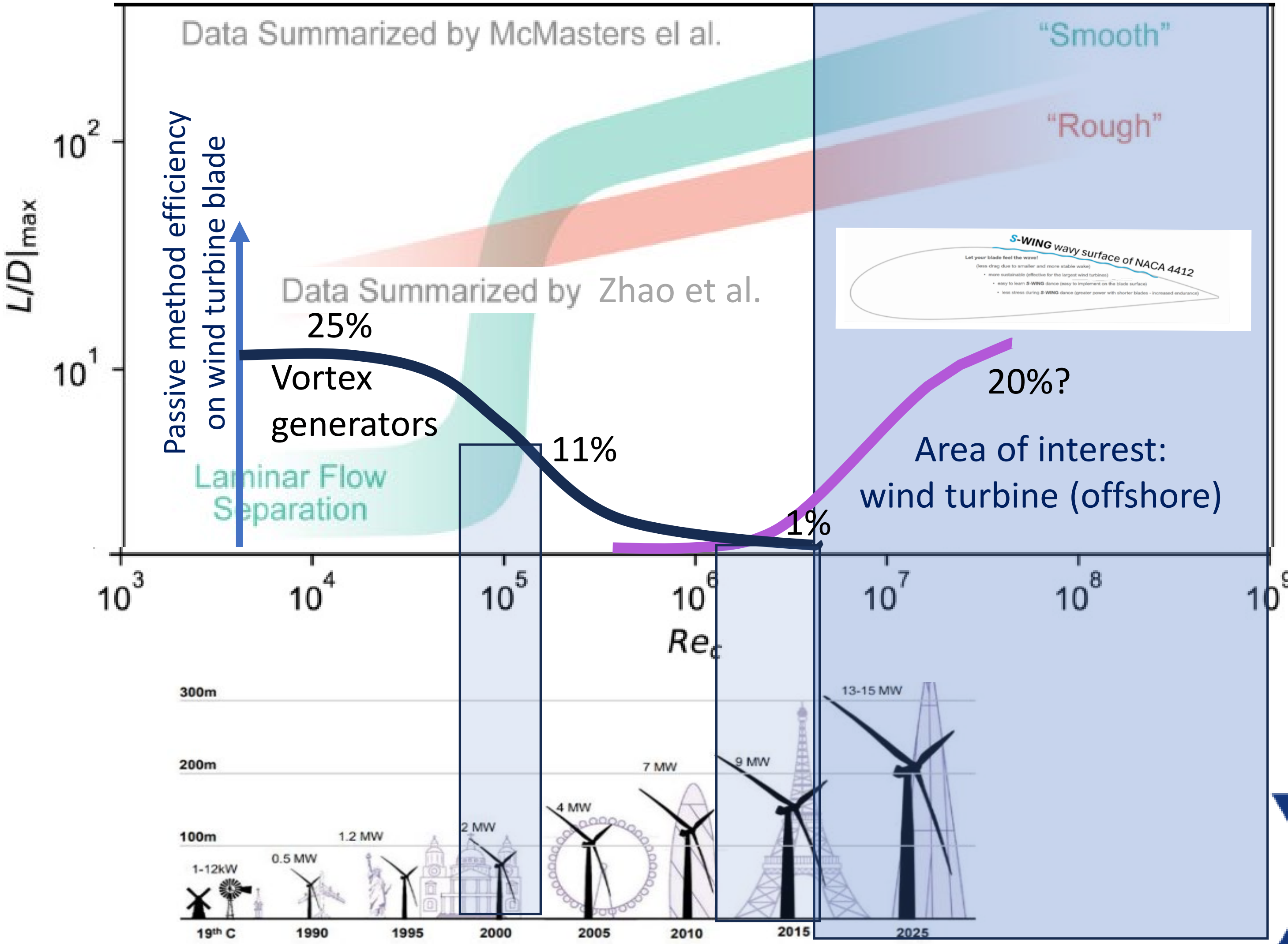
Passive Flow Control

Vortex generators efficiency:

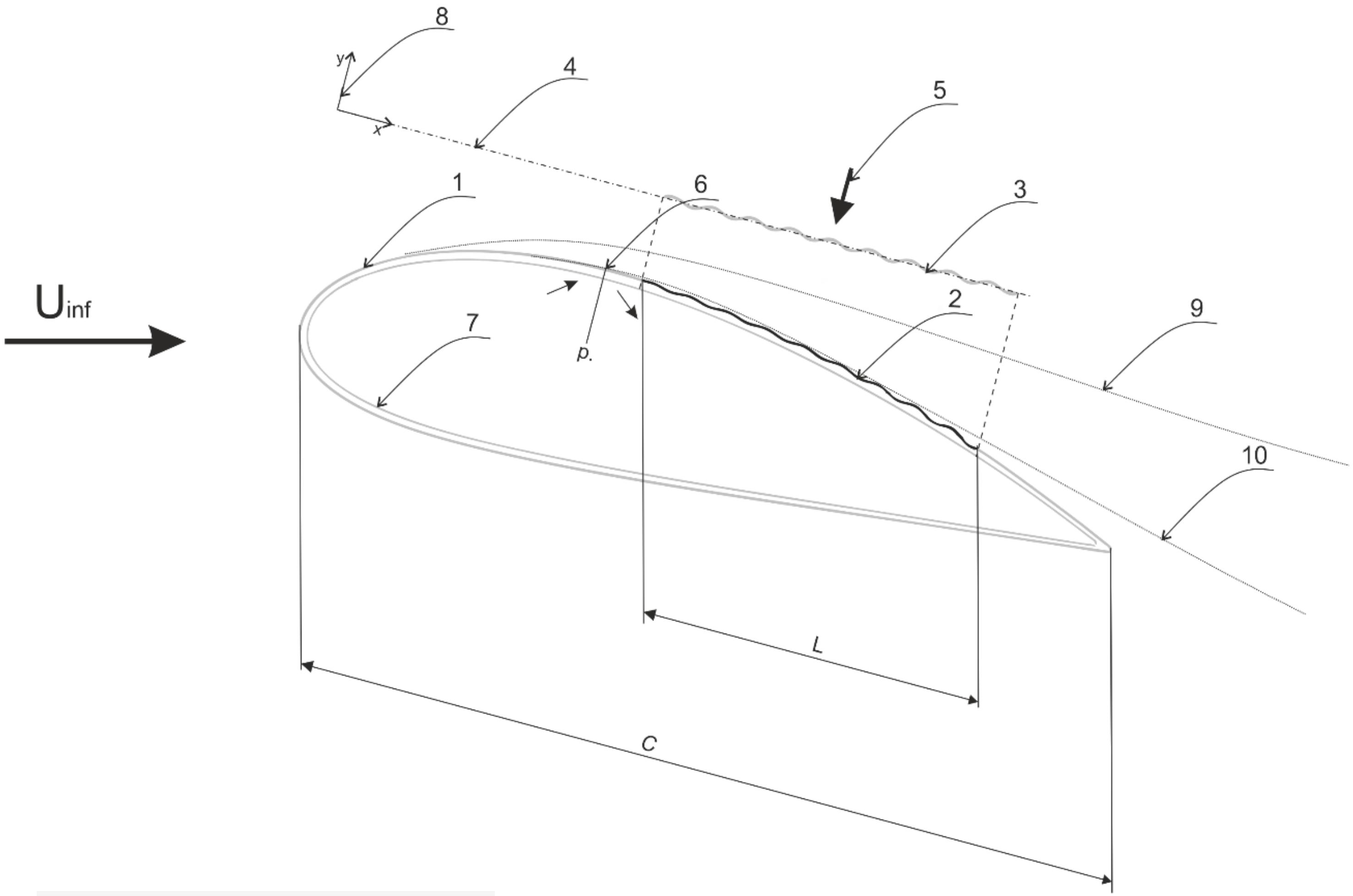
- airfoil exhibits a higher lift-to-drag for $Re_c < 10^5$ (for laminar separation).
- At 10MW wind turbine - 1% increase of power production.

$$Re_C = \frac{\rho U_\infty c}{\mu}$$





Patent features



1. Profile Exterior
2. **Undulating surface**
3. Coordinate along the freestream
4. **Sine function – (amplitude of 1-2 mm)**
5. Projection direction
6. The top of the wing
7. Inner surface of the profile
8. Lateral coordinate to the freestream
9. **Turbulent Boundary Layer (TBL)**
10. **Inner zone of TBL**

Features of the invention:

- **Sine wave amplitude and period is increasing according with the inne zone thickness of TBL**
- **Sine wave is skewed (steeper uphill side than downhill side of wave)**

*S*WING

*S***ubsonic** **W**ind-tunnel for **I**nclusive-**N**ext-**G**eneration (WING)

Experimental Thermal and Fluid Science 121 (2021) 110291

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journal homepage: www.elsevier.com/locate/etfs

ELSEVIER

Effective use of the streamwise waviness in the control of turbulent separation

Artur Dróżdż, Paweł Niegodajew, Mathias Romańczyk, Vasyl Sokolenko, Witold Elsner

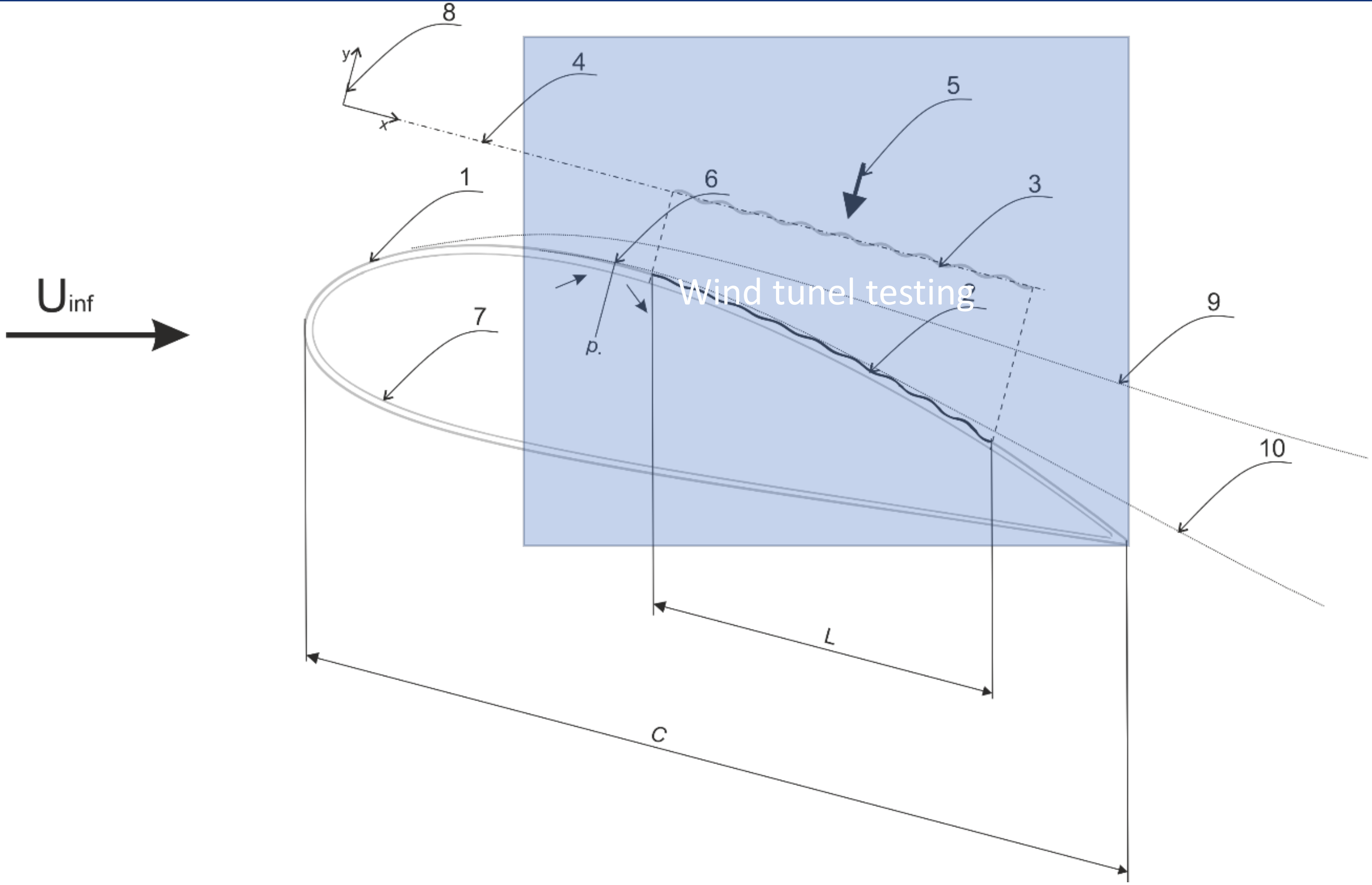
Czestochowa University of Technology, Institute of Thermal Machinery, al. Armii Krajowej 21, 42-200 Czestochowa, Poland

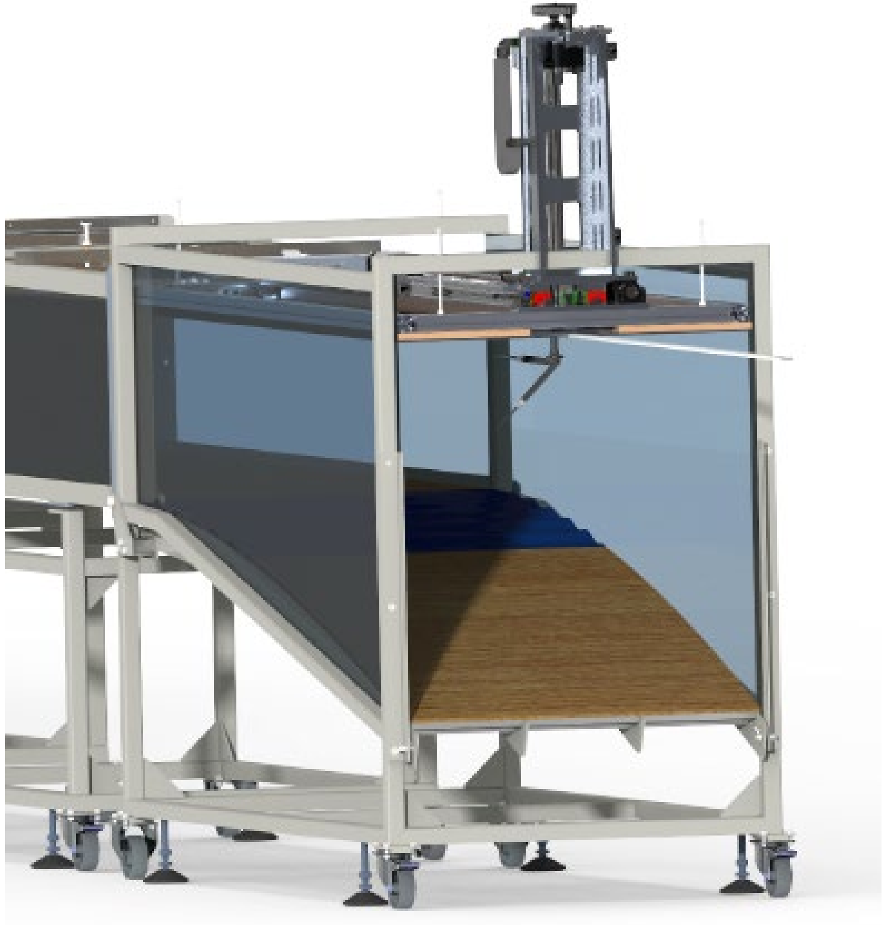
Flow condition:

U = 15 m/s
$x = c$ = 9.5 m
Re**x** = 10 millions

Re_c equivalent to 10 MW wind turbine blade

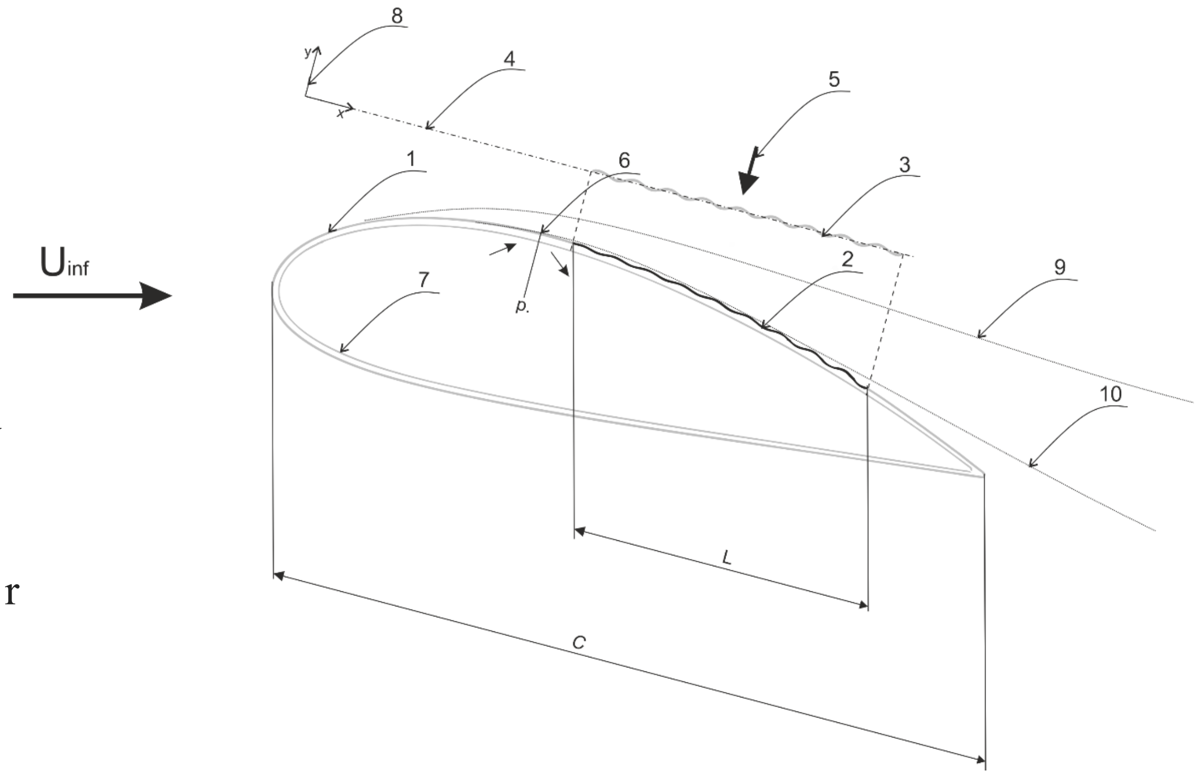
Experimental research





The various inflow condition and AoA will be tested in the laboratory

Site testing



The site testing requires the implementation of the wavy surface on the blade.

- Cooperation with R&D departments of Vestas and/or Siemens Gamesa (sharing the patent's rights).

NCBR (National Centre of R&D) in Poland requires the polish industry partner.

– Testing of the blade on one of the 15MW wind turbine that will be installed on the Baltic see in Poland.

A research collaboration for CETPartnership Joint Call 2024:

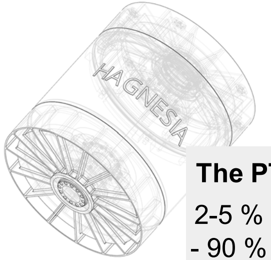
TRI2: Zero-emission power technologies

Hagnesia Wind AB

Liselotte Ulvgård, CEO Hagnesia Wind AB
liselotte.ulvgard@hagnesia.com

CETPartnership Joint Call 2024 - Contact Add

We develop a novel **direct drive generator** to help enable
technology leaps & massive material savings
for **wind and ocean energy** applications.



The PTF generator

2-5 % higher efficiency
- 90 % weight & material use
(incl REE magnets & copper)

⇨

Direct impact on wind and ocean energy

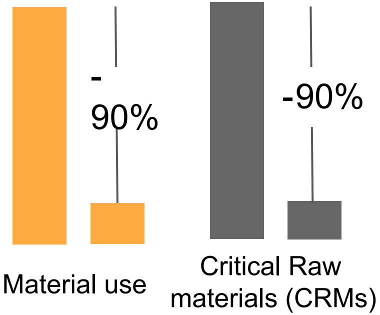
+ 2-5 % drivetrain efficiency in wind power
>10 % drivetrain efficiency for ocean energy
- 5-20 % in LCOE

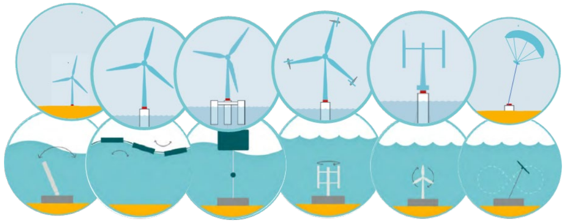
Solving the no. 1 supply chain risk (critical raw materials)

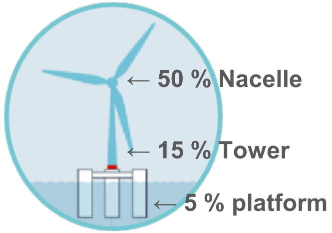
+

Indirect benefits at application level

→ Smaller and lighter drivetrain (no gearbox!)
→ Indirect material savings
→ Unlocking new and larger RE technologies







CETPartnership Joint Call 2024 - Contact Add

We develop a novel **direct drive generator** to help enable
technology leaps & massive material savings
for **wind and ocean energy** applications.

We are searching partners for **CM2024-03A/B**: *Advanced renewable energy (RE) technologies for power production*

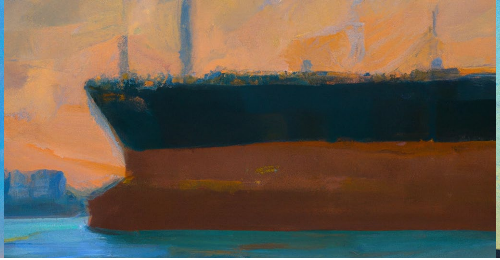
Looking for technology developers that

- Work with low speed & high torque applications (direct drive)
- Benefit from lightweight (and/or compact) drivetrain
- Are interested in feasibility studies, prototypes or demo projects

Checking most expected impacts

- ✓ Increase the energy conversion **efficiency**, contributing to zero-emission power production
- ✓ Increase technology performance
- ✓ Increase system efficiency by new modelling approaches, tools and methodologies
- ✓ Decrease investment cost and **LCOE** and/or improve the overall economics of the technology
- ✓ Optimise and decrease cost by coupling different power production technologies on the same site
- ✓ Reduce **environmental impact**
- ✓ Minimise the use of **critical raw materials (CRM)**
- ✓ Extension of the end of life and apply circularity-by-design approaches

+ *We have experience from both CETP and HORIZON applications!*

For further info, please get in touch with
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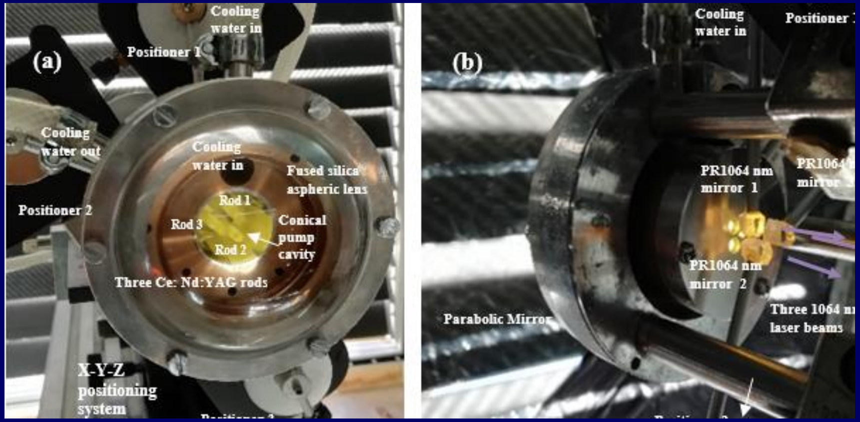
Pulsed solar-pumped Ce:Nd:YAG lasers for efficient and rapid hydrogen extraction from aqueous ammonia under ambient condition without catalyst (SOLAR-LASER4H2)



Dawei Liang

CEFITEC, Departamento de Física, FCT, Universidade Nova de Lisboa

2825, Campus de Caparica, Portugal

https://www.cefitec.fct.unl.pt/lasers


Prof. Dawei Liang


Dr. Joana Almeida


Dr. Cláudia Vistas

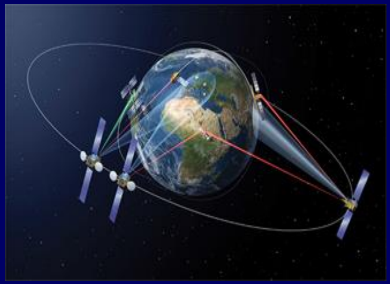
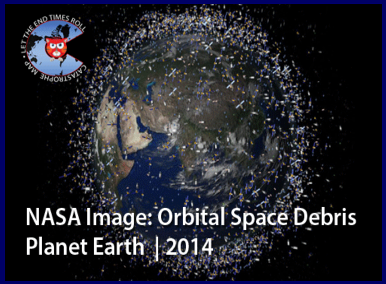

Dr. Bruno Tibúrcio


MSc. Dário Garcia


MSc. Miguel Catela


MSc. Hugo Costa

Solar-pumped lasers – Motivations and Applications

Solar-pumped laser may be considered as one of the most promising technologies in renewable energy and laser technology researches.

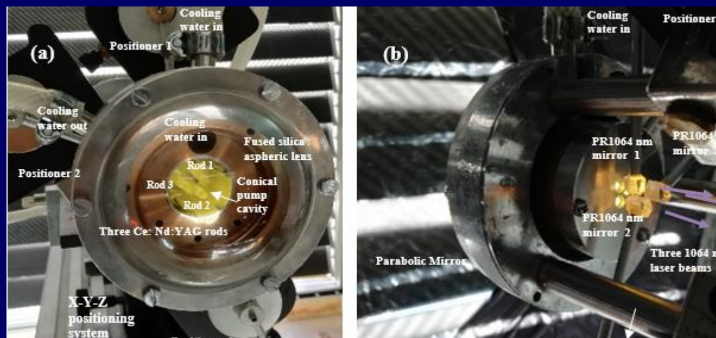
This type of renewable laser is unique since it does not require any artificial pumping source along with associated electrical power generation equipment.

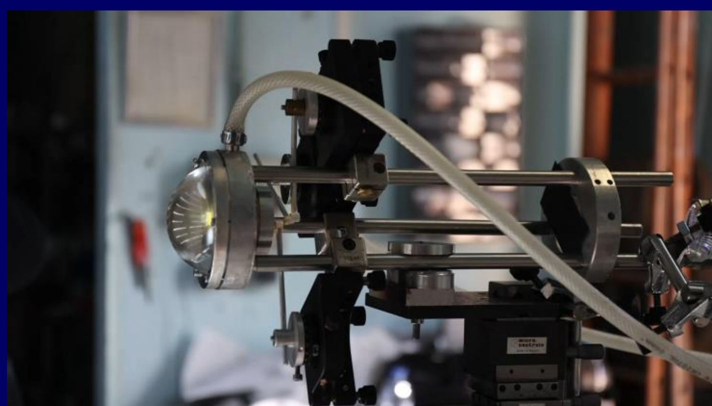
The direct excitation of large renewable lasers by natural sunlight may provide cost-effective production of coherent optical radiations, leading to numerous environmental and economic benefits.

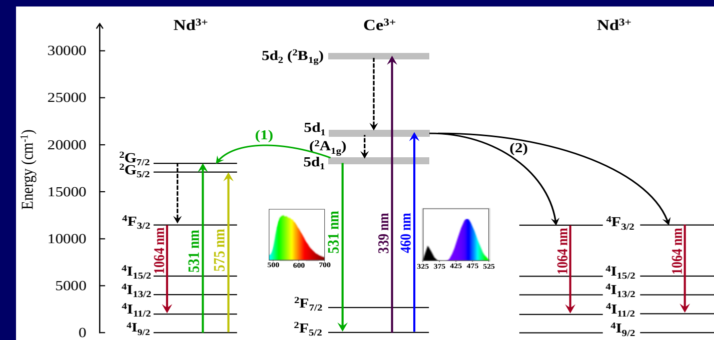
Powered by abundant solar energy, solar laser has large potentials for terrestrial applications such as laser material micro processing and multi-beam laser H_2 production.

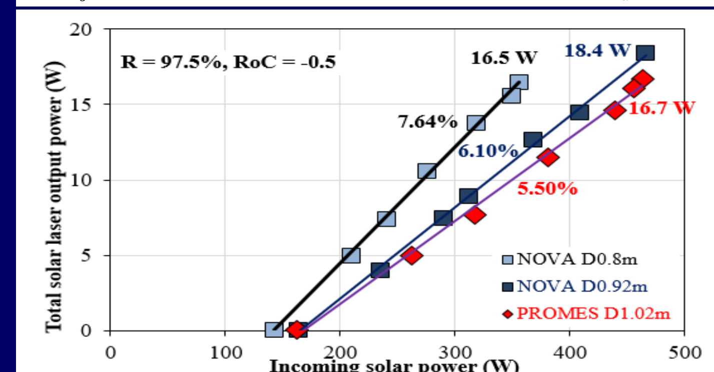
Simultaneous solar laser emissions from three Ce:Nd:YAG rods within a single pump cavity

(41.3W/m2 collection efficiency and 4.6% solar-to-laser power conversion efficiency)







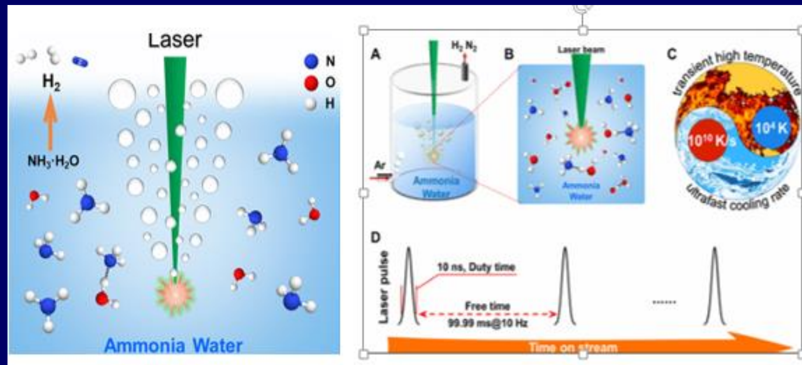


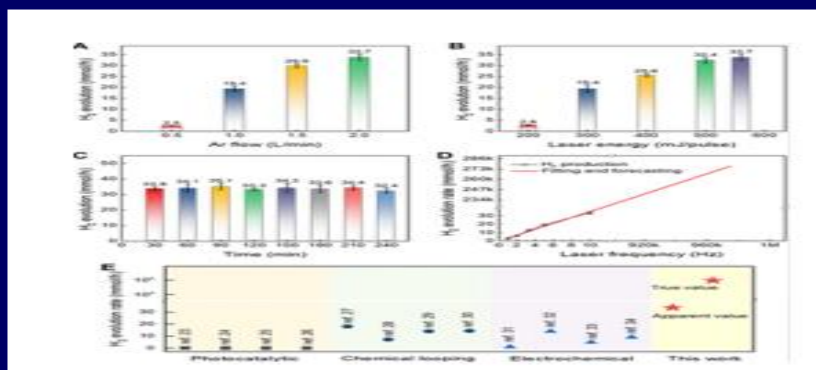
Solar pumping converts broadband sunlight into efficient laser light
A novel three Ce:Nd:YAG rod solar-pumped laser achieves 4.64% solar-to-laser energy conversion efficiency.

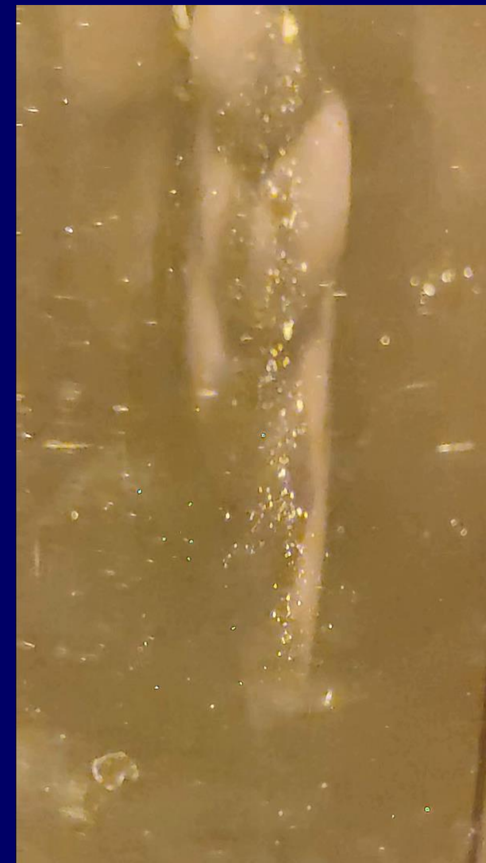
LASER FOCUS WORLD Oct. 4th (**2022**)

Liang et. al. Sol. Energ, Mat. Sol. Cells. 2022 33 Citations

The state-of-the-art of H_2 extraction from aqueous ammonia





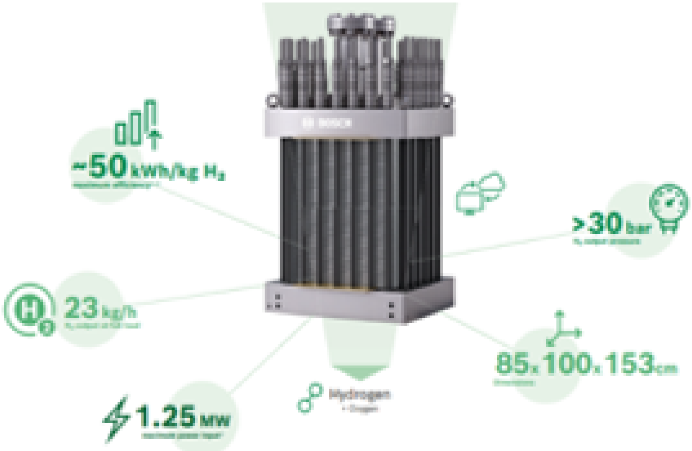


Bo Yan, Yinwu Li, Weiwei Cao, Zhiping Zeng, Pu Liu, Zhuofeng Ke, and Guowei Yang
Efficient and rapid hydrogen extraction from ammonia–water via laser under ambient conditions without catalyst
J. Am. Chem. Soc. 2024, 146, 7, 4864–4871, Pub. Date: 2024-02-09
https://pubs.acs.org/doi/10.1021/jacs.3c13459

An example of commercial electrolysers

A Bosch PEM electrolysis stack is capable of producing 23 kilograms of H_2 per hour, for 1.25 Megawatts electrical input power. In another words, by using the most advanced mulijunction PV module with 40% efficiency, the Bosch PEM electrolysis stack can produce 23 kilograms of H_2 per hour, for 3.125 Megawatts free solar input power. https://www.bosch-hydrogen-energy.com/electrolysis/

Bosch PEM electrolysis stack



For our case, for 1.73 m^2 solar energy collection area, 1000 W/m^2 solar irradiance, and 40% multijunction PV module efficiency, 0.692 kW electric power can be generated and then used to power a small BOSCH electrolysis stack, **12.73** gram of H_2 per hour yield can be calculated (0.692 kW/1250 kW × 23 kg/h =12.73 g/h).

Pulsed solar-pumped Ce:Nd:YAG lasers for efficient and rapid hydrogen extraction from aqueous ammonia under ambient condition without catalyst (SOLAR-LASER4H2)

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Alejandro Datas (Associate Professor), Instituto de Energía Solar. Universidad Politécnica de Madrid
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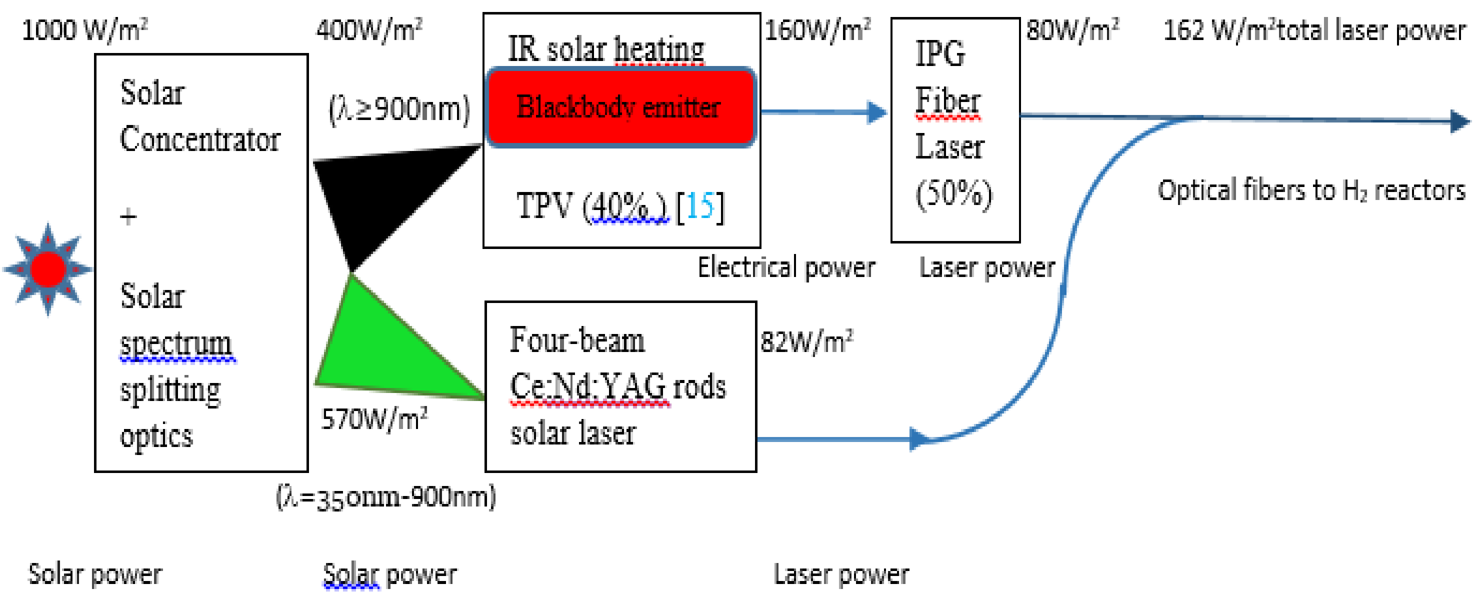
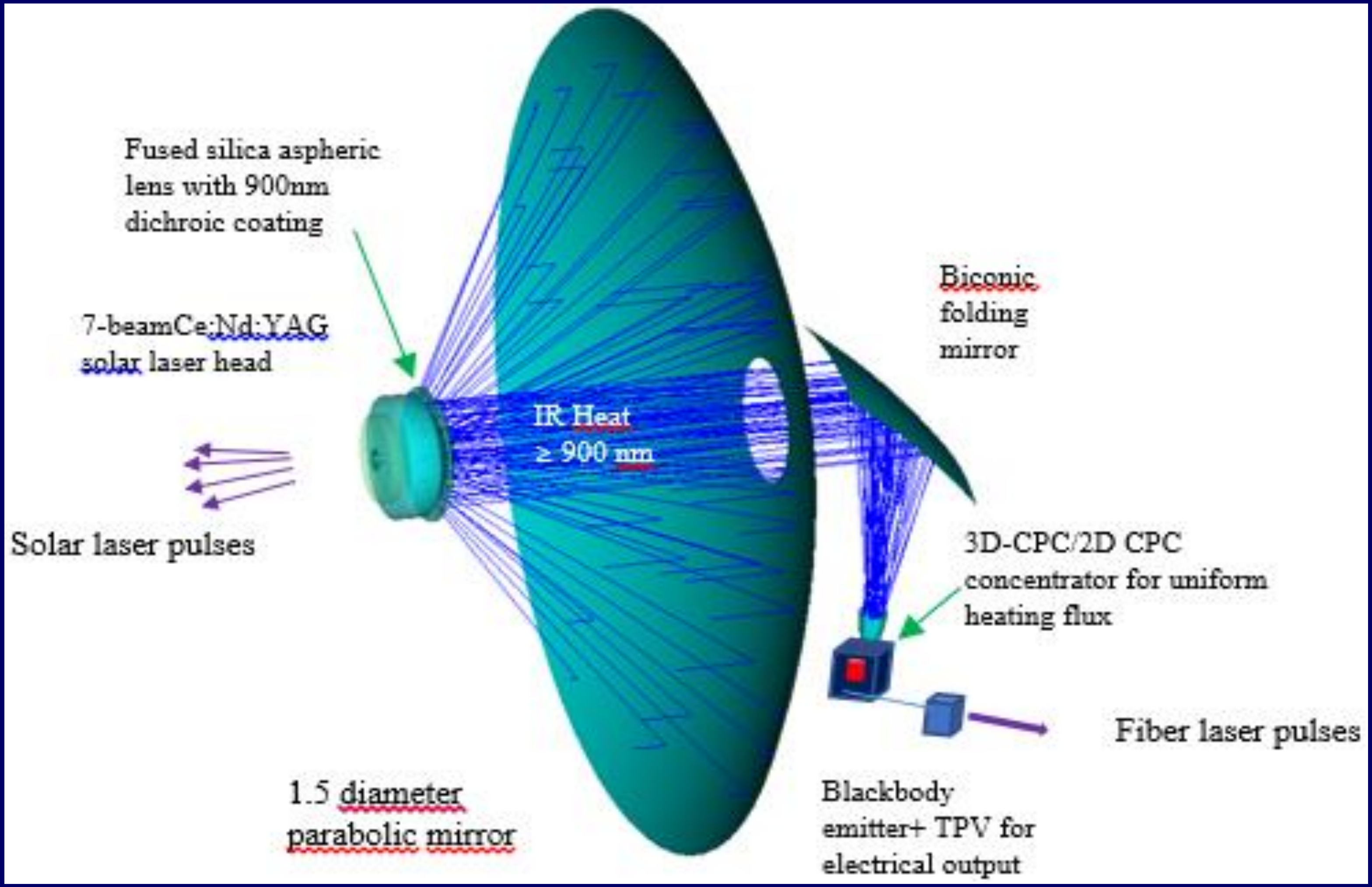
(Future 15.5% Total solar-to-laser conversion efficiency)

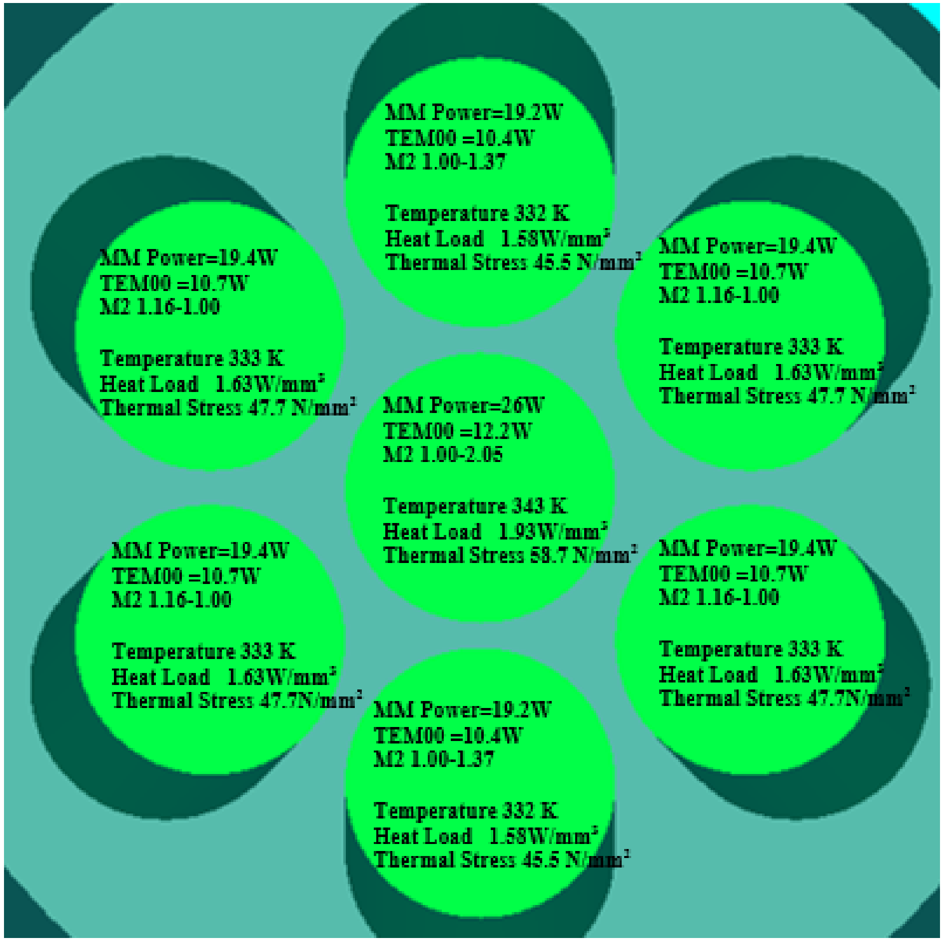


Simultaneous solar laser and fiber laser power production through a parabolic mirror



Zemax and LASCAD optimization of multimode, TEM_{00}-mode solar laser power, M2 factors, and thermal effects of the seven Ce:Nd:YAG rods

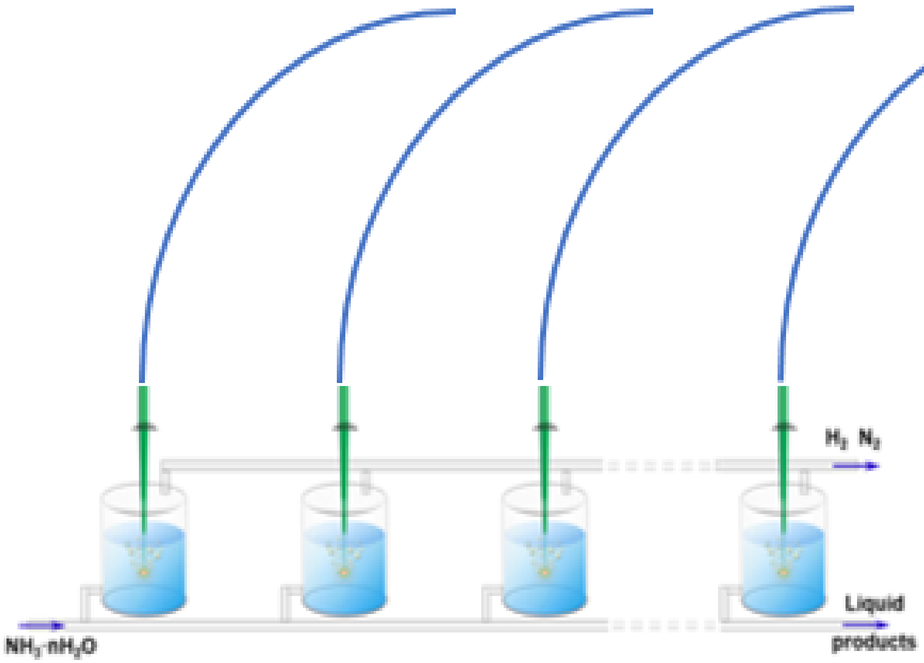
Total Multimode Laser Power = 142W **82.0 W/m^2** collection efficiency
Total TEM_{00}-mode Laser Power = 76W 44.0 W/m^2 collection efficiency



Coupling laser pulses to H_2 reactors

Fibre 1 Fibre 2 Fibre 3 …… Fibre 7

Laser pulses coupling from the 2 pulsed four-beam solar laser heads



7 fused silica H_2 reactors with aqueous ammonia

7 solar laser pulses with several hundred mJ pulse energy,10 ns pulse width can be efficiently transmitted the H_2 reactors by 7 optical fibres.