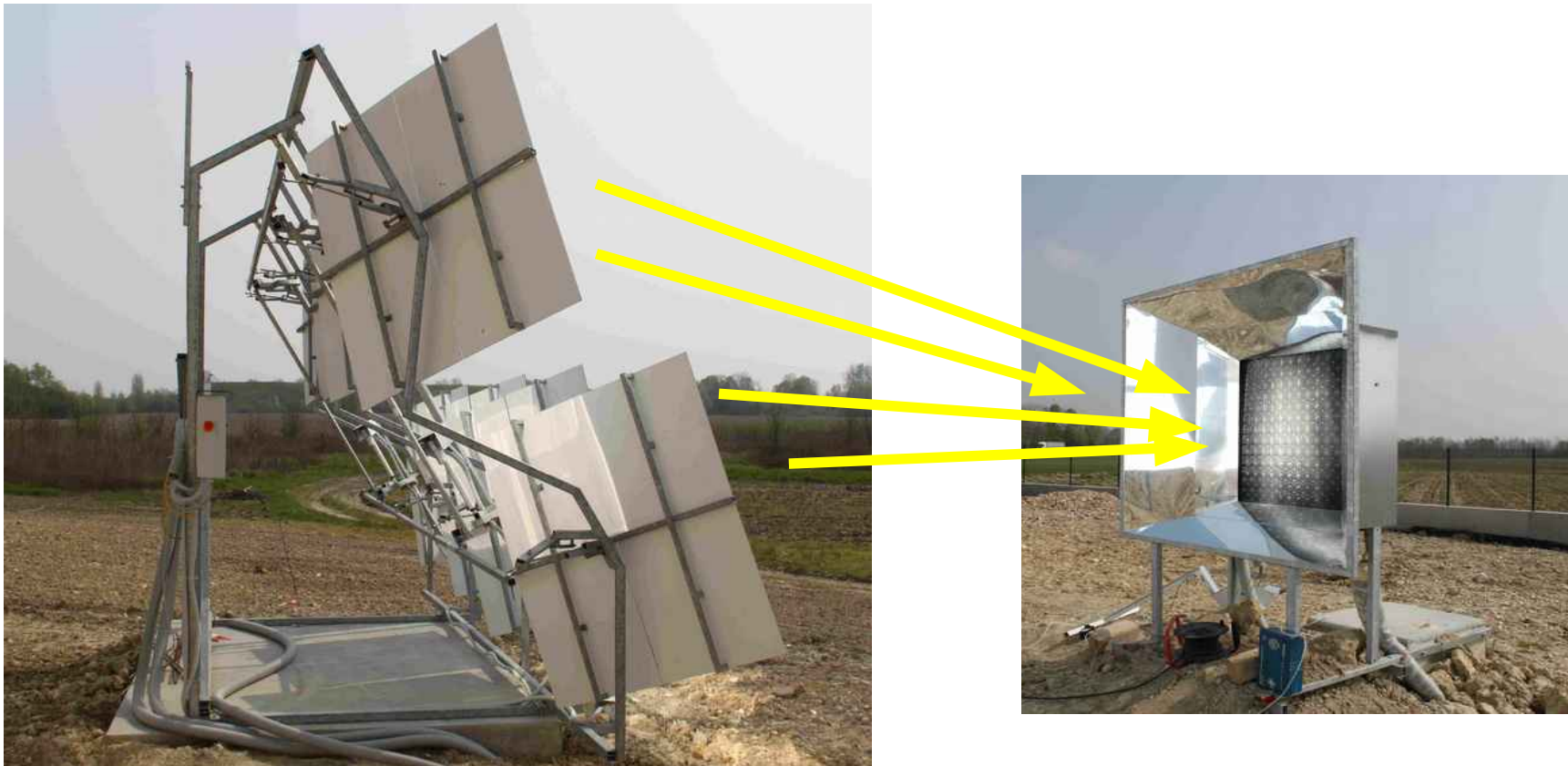


The Linear Mirror for roasting biomass

Hans Grassmann,
University Udine, Isomorph srl

The Linear Mirror

Consists of mirror elements, which are mechanically connected so they move concurrently and reflect concentrated sun light on a heat exchanger, which remains in a fixed position.



Grassmann, H., et al. (2013) First Measurements with a Linear Mirror Device of Second Generation. Smart Grid and Renewable Energy, 4, 253-258

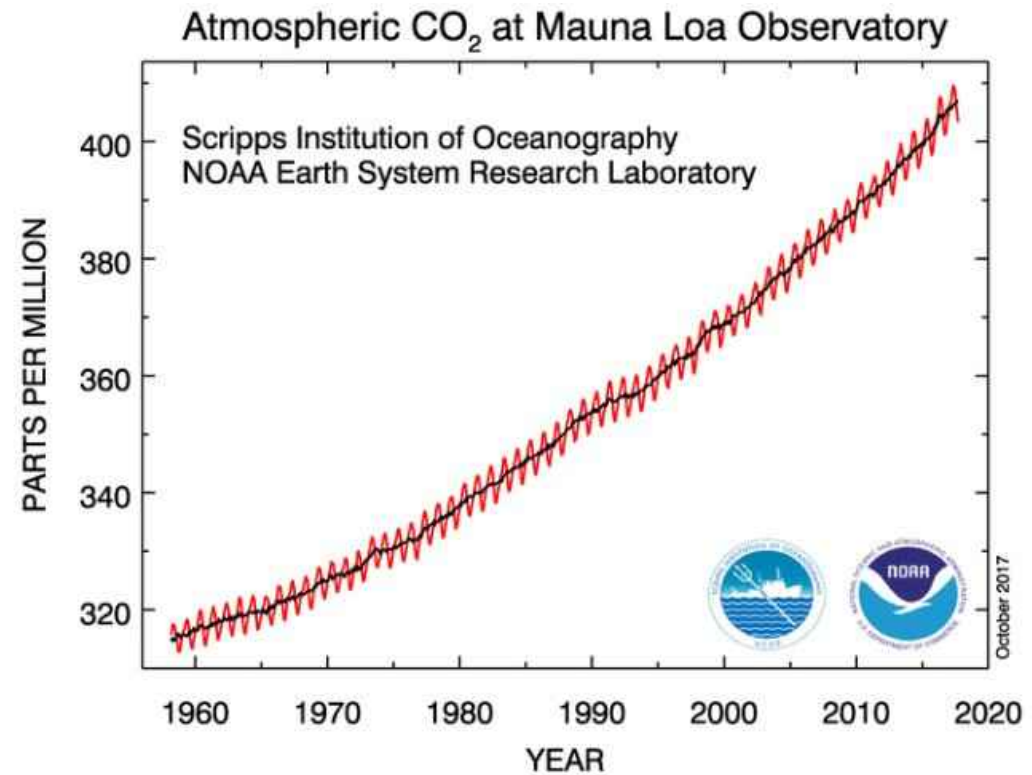
Motivation

Already today, renewable energies provide a good part of electrical energy: photovoltaics, wind, water.

But only a few percent of heat energy come from renewable sources,

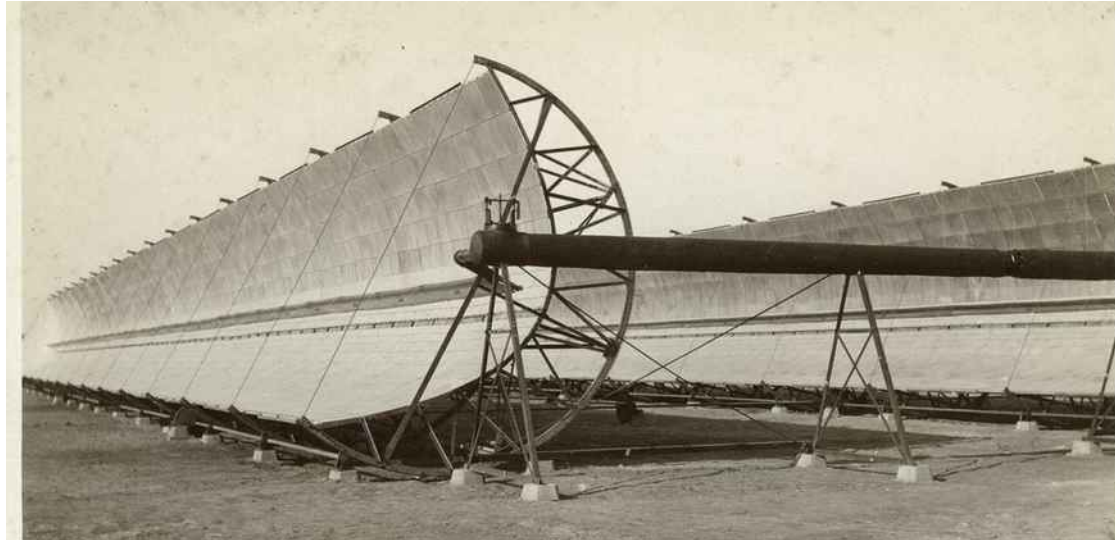
While instead our consumption of heat energy is larger than that of electrical energy.

=> in order to stop CO₂ increase,
New technologies for renewable
Heat energy are needed.



Conventional Solar Technology

For many years



**1912, Maadi,
Egypt**

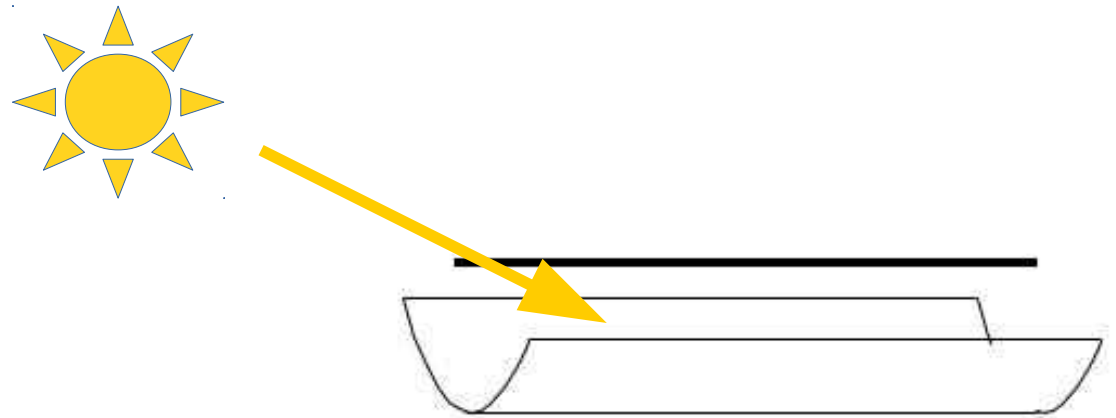
and until recently, parabolic troughs were suggested for providing solar energy.



From Google Maps you can see, that these plants are oriented towards south, So that they follow the sun in azimuth during the day.



But they do not follow the sun in Zenith



It is then evident, that north of Sicily for most of the year the sun shines on these troughs under a small angle. The device is efficient only in summer.

example: DD srl, Meret di Tomba

2014 Caveja Nord srl (Udine, Ing.Causero) **Udine Solar** – intended investment **30 Millionen Euro**

chiesto in Regione la
valutazione di
impatto ambientale

La struttura è frutto
di un brevetto
del premio Nobel
Carlo Rubbia

di Giacomina Pellizzari

Archiviata la discarica, a Modoletto (Cussignacco), il Consorzio dei cimatori di ghiaia "Caveja" punta su un impianto a concentrazione solare termodinamico denominato "Udine solare". Il progetto frutto di un brevetto del premio Nobel Carlo Rubbia, è stato presentato in Regione e in Comune per la Valutazione d'impatto ambientale (Via). L'obiettivo è produrre energia elettrica incamerando il calore del sole e riscaldare così gli edifici pubblici e privati di Udine Sud. L'investimento ammonta a 30 milioni di euro per un impianto destinato ad andare a esaurimenti in 25 al massimo 30 anni. Il centrodestra, al quale la proprietà ha già illustrato il progetto, valuterà l'impatto con la cittadinanza nel corso di un'assemblea pubblica che organizzerà a breve.

Il progetto messo a punto dalla DD Srl di Mereto di Tomba partner di Caveja e fornitrice della tecnologia Csp (Concentrated solar power), prevede «l'utilizzo di specchi parabolici lineari in grado di inseguire la direzione del sole per focalizzare la radiazione solare su un tubo ricevitore posizionato lungo il fuoco della parabola. L'energia solare assorbita dal tubo ricevitore sarà trasferita a un fluido di lavoro (miscela di sali fusi). Il calore raccolto - si legge nella relazione - sarà utilizzato per la produzione del vapore che, a sua volta, alimenterà una turbina destinata alla produzione di energia elettrica. Parte del calore sarà stoccato in grandi serbatoi di accumulo, contenenti la stessa miscela salina, e utilizzato successivamente per la produzione di energia elettrica durante le ore di bassa o assente insolazione».

«Siamo in grado di coprire 224 mila metri quadrati di superficie e di eliminare 1.500 caldaie domestiche» spiega l'ingegner Mario Causero nel ricordare che questo sistema di teleriscaldamento contribuirà a ridurre l'inquinamento da polveri sottili (Pm10) prodotto dalle caldaie domestiche.



A CUSSIGNACCO

Al posto della discarica una centrale solare

Il consorzio Caveja investe 30 milioni per realizzare il progetto a Modoletto
L'obiettivo è produrre energia elettrica con un sistema di specchi parabolici

to da polveri sottili (Pm10) prodotto dalle caldaie domestiche. «L'accumulo del calore serve a compensare il giorno con la notte» aggiunge l'ingegnere nel ricordare che l'energia prodotta potrà essere venduta all'Enel, ma anche alla Ziu o alla Zau. Contatti per la stipula dei contratti sono in

corso con il Mercato ortofrutti-colo. Si tratta di una tecnologia collaudata in Germania e in Austria dove l'acqua arriva nelle case a 80 gradi. È se per la casa singola l'adeguamento al nuovo impianto non è facilissimo, lo stesso non si può dire per i condomini che, una volta adeguati all'impianto di teleriscaldamento, risparmieranno tutti i costi di gestione e di manutenzione delle caldaie.

L'obiettivo sarà estendere il nuovo metodo di riscaldamento nel depuratore, nell'impianto di trattamento rifiuti Net, all'ex Cogelo e al canile. Ma anche al boccidromo e agli impianti sportivi di Cussignacco.

«L'impatto ambientale non esiste - sottolinea l'architetto Luciano Snidar - visto che l'impianto non modifica il terreno che resterà coltivato a prato. I pannelli, infatti, saranno installati a un metro e mezzo da terra e quando l'impianto sarà esaurito, si smontano senza creare alcun problema».

Il progetto sta facendo discutere favorevolmente anche se a palazzo D'Arco sono in corso alcuni approfondimenti urbanistici per capire se un'area verde può essere trasformata in una centrale di produzione di energia elettrica.

L'INTERROGAZIONE

Della Rossa: un forno nel cimitero di Paderno



«Installiamo un forno crematorio anche nel cimitero di Paderno». Ad avanzare la proposta è il vice presidente del consiglio comunale, Franco Della Rossa, preoccupato per i disagi che stanno provocando alle famiglie dei defunti le continue interruzioni dell'impianto installato, nel 1992, nel cimitero di San Vito. Allo stesso modo, Della Rossa, sollecita la realizzazione di una decina di obitori sempre nel camposanto di Paderno. Il vice presidente del consiglio comunale ha presentato un'interrogazione per chiedere al sindaco, Furio Honsell, l'illustrazione degli investimenti dedicati ai cimiteri

cittadini. «Considerate le continue sospensioni del servizio e i costosi interventi effettuati finora per garantire la manutenzione ordinaria e straordinaria dell'impianto di cremazione, valutiamo se realizzare nuovi obitori e un altro forno nel cimitero di Paderno dove, negli anni scorsi, è stata inaugurata la sala per le cerimonie religiose e laiche» insiste Della Rossa. Nell'evidenziare che, da tempo, molte famiglie per evitare di rimanere in coda sono costrette a rivolgersi altrove. Anche fuori provincia. Non va dimenticato, infatti, che sempre più persone decidono di farsi cremare.

 FINO AL 30% DI SCONTO SU TUTTA LA GAMMA BMW Km/0

MessaggeroVeneto



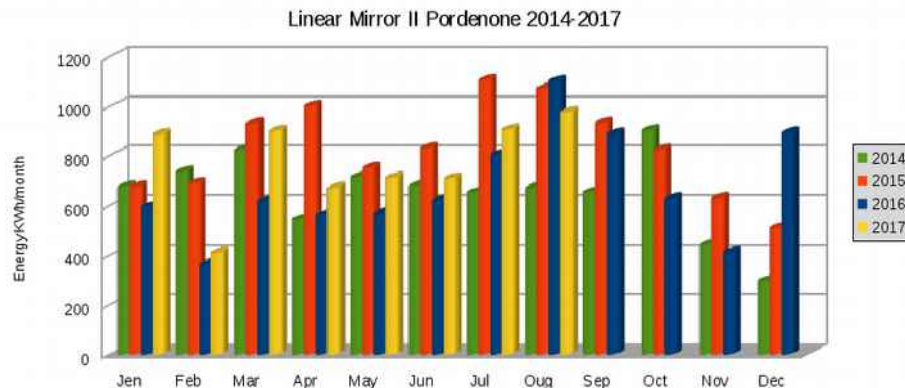
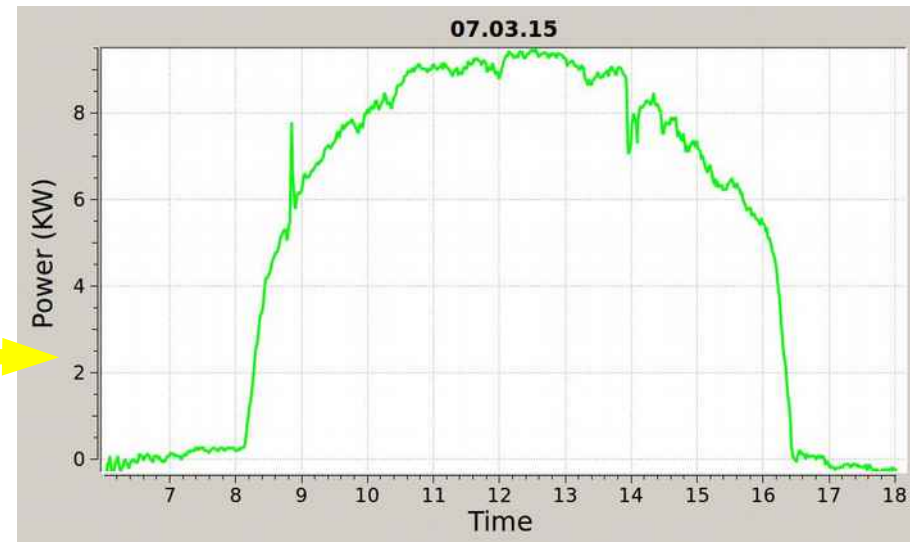
Our consultancy has contributed to avoid a loss of 30 million Euros, and to avoid a further image problem for solar energy.

The Linear Mirror works well also north of the Alps



Germany (Puettlach)

The first Linear Mirror was installed in 2014 at the hotel “Il Cavaliere” at Pordenone (Italy). The owner is very satisfied, the installation can be visited. Its performance has been published.



The installation has been working by now for 5 years, without problems, and can be visited.

Economics

The Linear Mirror has up to 8 kW thermal power
substitutes 1000 l of heating oil per year

Certified Solar Keymark, therefore eligible for state incentives in many countries

Example Italy:

- => - conto termico up to 12.000 Euro or 65% of total cost
- R&D projects additional 50%
- super and iperammortamento

these incentives add up to 100%

That means, that for companies the whole plant (including installation etc) can be paid for by the state for up to 100%.

Economics



Up to now we are producing single pieces
In our workshop at Gorizia (financed by fondo Gorizia with 90.000 Euro)

=> therefore still a price of **8.500 Euro** +tax, trasport, Installation

Future: industrial production, lower price.

Pay back time

1) The Linear Mirror consists of hot galvanized steel and aluminium
=> long service time

2) Future versions of the Linear Mirror cannot be more efficient
(because the theoretic maximum is almost reached already)
=> no need to substitute a Linear Mirror, once it is working.

(1) and (2) =>

The amortization of a Linear Mirror should be compared to that of a building, rather than that of a tool or a computer.

However, as an investment the Linear Mirror is safer than a building

Because a building can lose its value due to economic developments
If instead a Linear Mirror is not anymore of use at its place, it can be transported to a different location by truck.

TRADUZIONE DEL TESTO DEL BREVETTO EUROPEO N. 2 901 090

Disposizione di riflettori solari e procedimento per l'orientamento dei riflettori.

Isomorph S.r.l.,

con sede a Duino-Aurisina (Trieste)

* * * * *

D E S C R I Z I O N E

La presente invenzione si riferisce ad una disposizione di riflettori solari per la deviazione di raggi solari incidenti su un obiettivo comune, ad un supporto dei riflettori per una simile disposizione dei riflettori solari ed un corrispondente procedimento per la deviazione di raggi solari incidenti sull'obiettivo comune.

High temperatures

In its standard version – Solar Keymark certified – the Linear Mirror heats water up to 100°C.

But the Linear Mirror can provide also much higher temperatures, As are required by many industrial application (process heat), also for solar cooling.

Heat exchanger sun-air

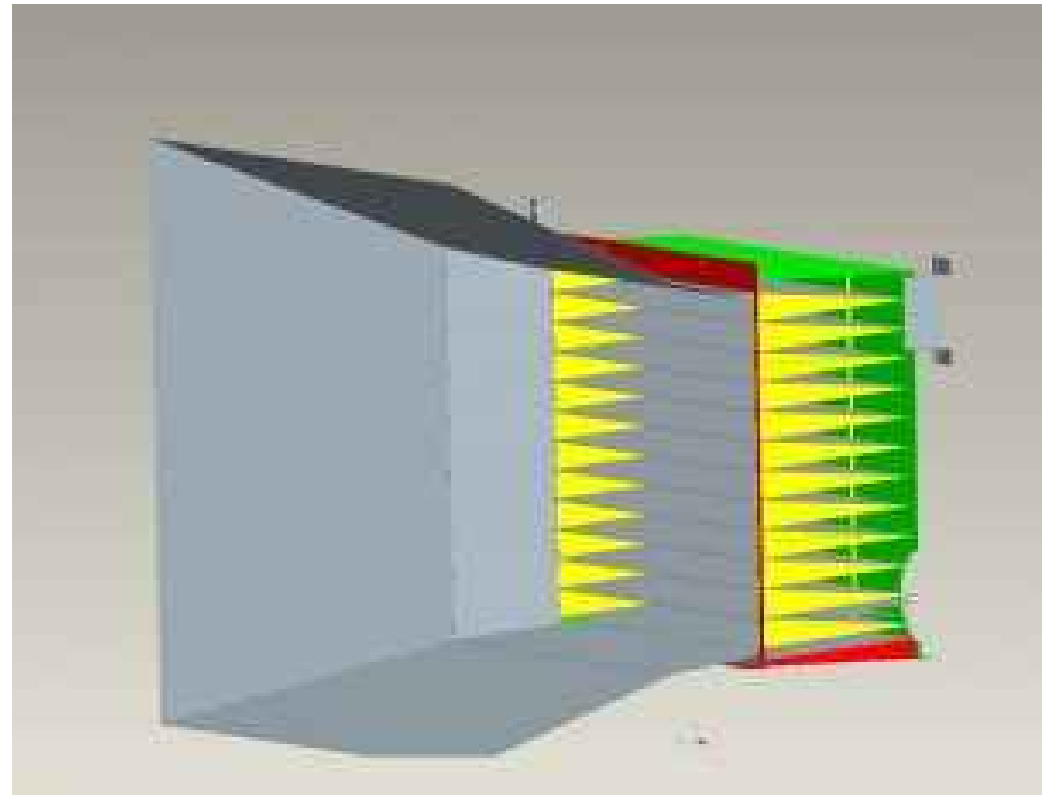
In order to make the provision of higher temperatures for industrial processes easy, we have developed a totally new kind of sun-air heat exchanger.

The selective surfaces of normal solar heat exchangers usually are not suited for high temperatures.

Therefore we have developed a new technique – an absorbing surface, which is selective not with respect to wavelength, but with respect to the spatial direction.

Described in:

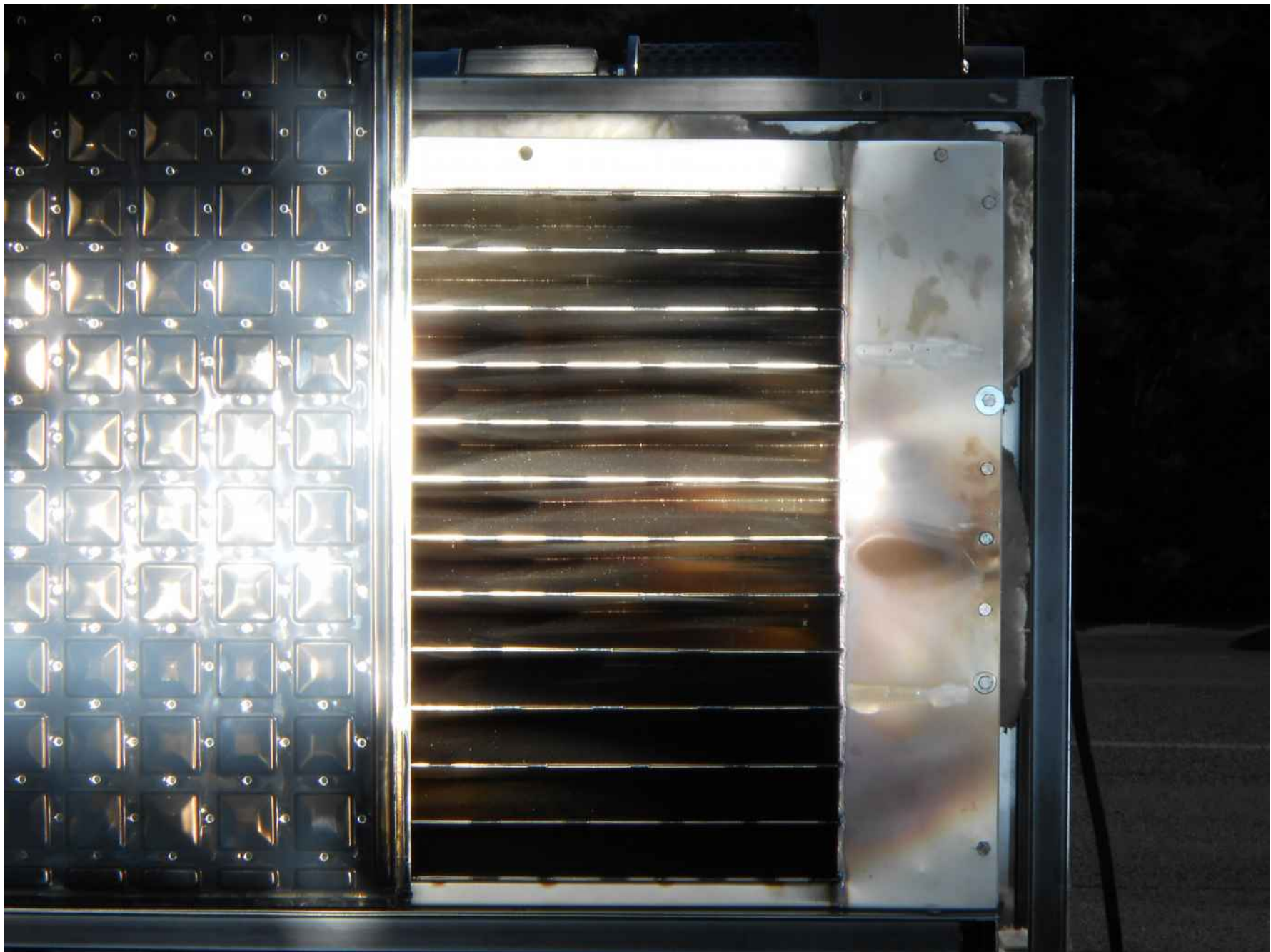
Development and Test of a New Solar-Air Heat Exchanger for the Linear Mirror II System, Hans Grassmann, Marco Citossi, Smart Grid and Renewable Energy, 2019, 10, 155-164



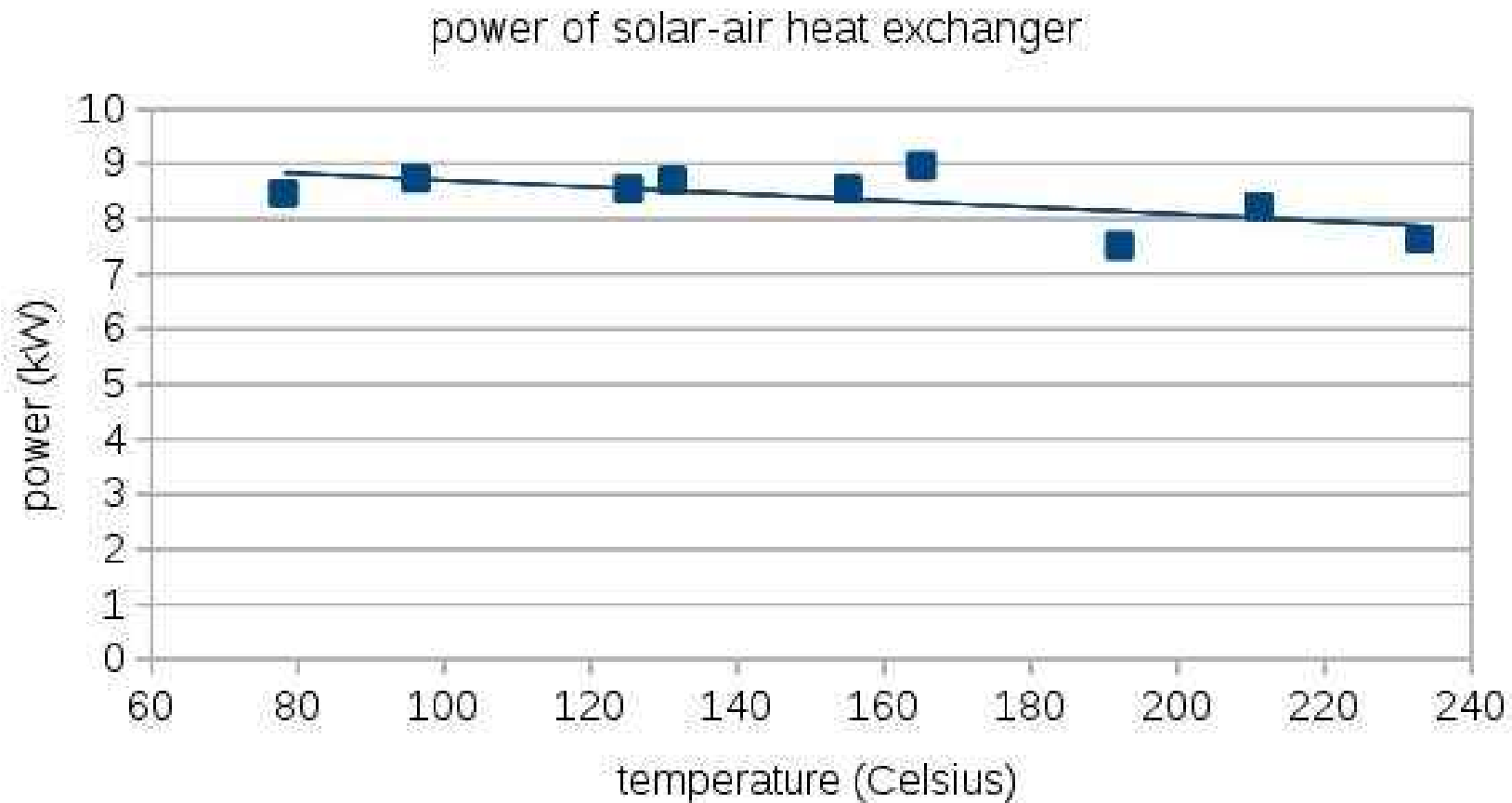
The surface of the absorber is made of polished steel.



The heat exchanger can operate in open or closed circuit.



The absorption of its mirror plates (polished steel) is better than that of a conventional black sun-water heat exchanger.



Our sun-air heat exchanger is at high temperatures (200°C)
as efficient
as the sun-water heat exchanger at lower temperatures (100°C)

Still higher temperatures can be reached efficiently by increasing the number
of reflectors of the Linear Mirror, which is easy.

Solar Carbon

The Linear Mirror can be integrated easily not only into existing industrial processes,
but also into the research projects of the European Community. Example:

Roasted biomass => “vegetal carbon”

substitutes

if gasified

with Fischer-Tropsch

fossil coal

fossil gas

fossil oil



<https://www.sector-project.eu/>



GA no 282826

Production of Solid Sustainable Energy Carriers from
Biomass by Means of Torrefaction

Deliverable No. D10.2

Torrefaction Technology and Strategy Report

Limitation of traditional torrefaction technology:

The biomass gets torrefied burning it in part

- => - low efficiency
- several processes happen in parallel, and influence each other

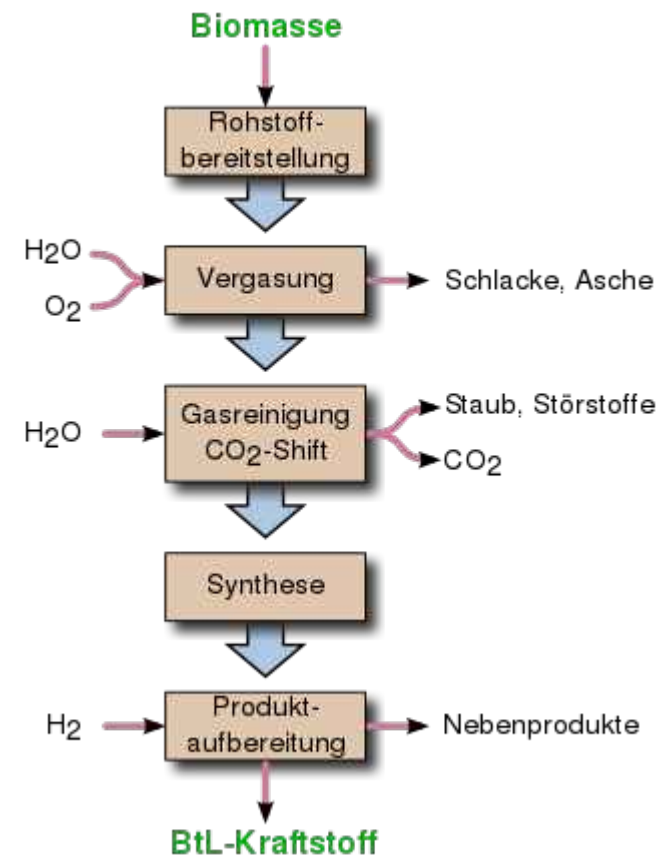
=> difficult to industrialize

example:

Choren (with VW, Daimler, Royal Dutch Shell) :
Synthetic fuel directly from biomass

=> failed

Verfahrensschema der BtL-Herstellung



The Linear Mirror is a "game changer",

because it heats the biomass externally

=> increases efficiency, disentangle different processes

goal:

By means of external solar heating

Create from many different kinds of biomass

A standardized material "solar carbon"

Which can be gasified with a simple standard gasifier

(like is the case for fossil fuels, which are standardized materials, which can be used always with the same kind of burner.)

The production of synthetic fuel from coal is an existing industrial process, example: SASOL

A Linear Mirror, which produced in 1 year 10.000 kWh energy heating water,
can provide 5 times as much energy producing solar carbon

This can further be increased by a large factor by means of recuperating the
heat energy

Solar carbon is a way of storing solar energy for long periods of time

Apart from the biomass, which is collected by Companies like A&T 2000 in the municipalities

There are many other kinds of unused Biomass:

example Italy:

- 5 million ton cereal straw

- 5 million tons maize straw

- 1 million tons rice straw

Quantities:

For a typical steam turbine in a power stations of 160 MW (example Monfalcone), which runs 6000 hours per year

$160 \text{ MW} \times 5.000 \text{ h} \times 3 \text{ (efficiency)} = 2.400 \text{ GWh}$

$1 \text{ ton straw} = 3.5 \text{ MWh} \Rightarrow \text{consumption of } 685.000 \text{ tons straw/year}$



From literature and internet sources we were made believe, that biomasses must be heated to more than 300°C in order to obtain a high quality combustible

For this reason we had used in our first study a simple rotary kiln for performing a solar pyrolysis at high temperature and published the results:

Grassmann, H., Boaro, M., Citossi, M., Cobal, M., Ersettis, E., Kapllaj, E. and Pizzariello, A. (2015) Solar Biomass Pyrolysis with the Linear Mirror II. Smart Grid and Renewable Energy, 6, 179-186. <https://doi.org/10.4236/sgre.2015.67016>

Subsequently, a PdD Thesis at the institute of engineering of the University of Udine has studied in detail the properties of the various solar carbons (Marco Citossi).

However, developing the gasification of the solar carbon

We found, that many materials do not need to be heated to high temperatures in order to be a suited for gasification.



At the current state of our work (much detailed investigation still needs to be done) it seems

That high pyrolysis temperatures are needed, if the material is to be burned in the conventional way

But if the material is to be gasified, a slight roasting often is sufficient.

We have verified this to be true for the biomass collected by A&t 2000, and also potatoes, used coffee powder, yogurt

The preferred technology for the future is gasification.

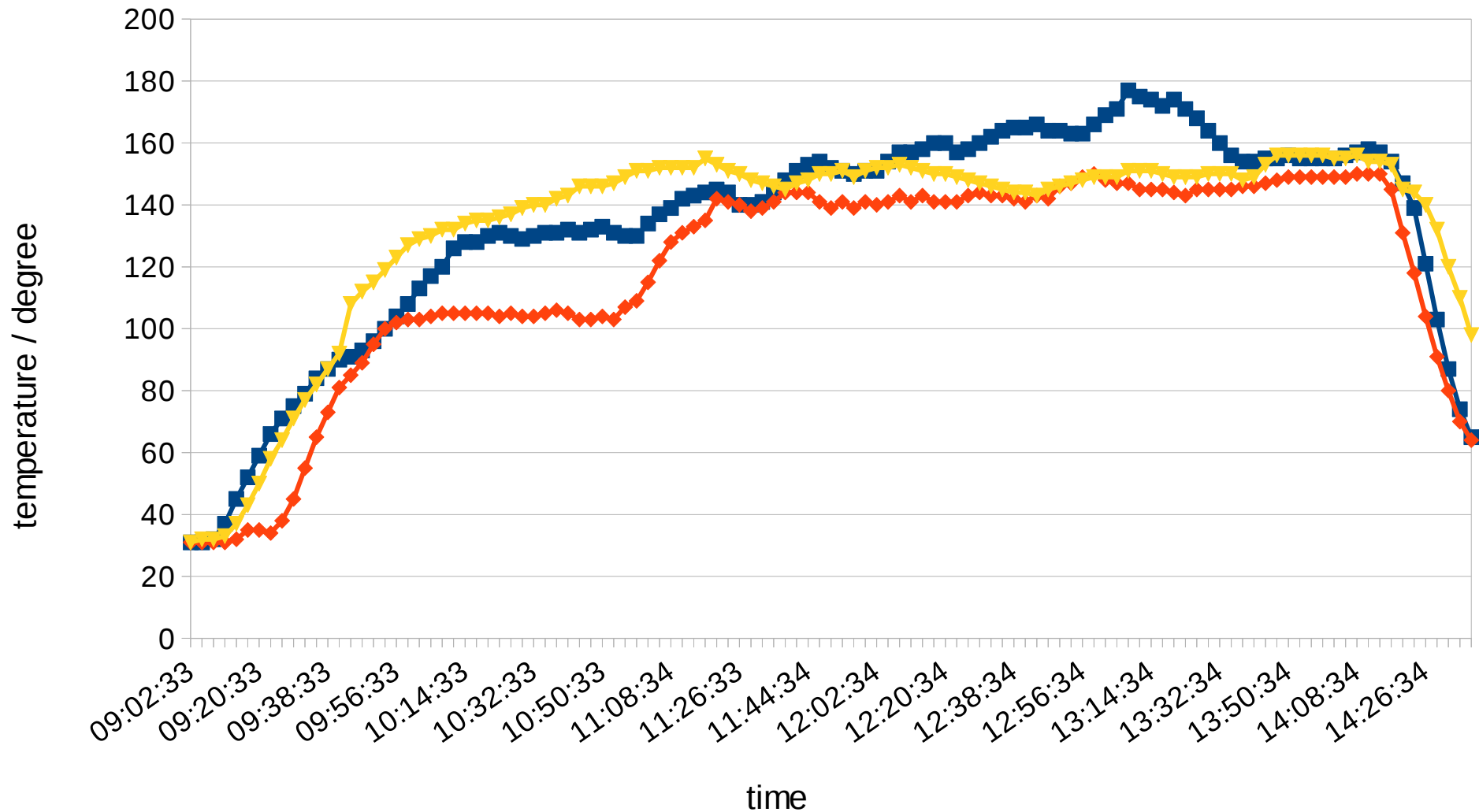
The solar plant of A&T 2000 is able to produce

“from nothing” (=biomass, whose transportation and disposal has already been paid for by the municipality)

about 30 tons of solar carbon per year, equivalent to 15 tons of fossil oil.



Air Temperature



The first test runs were very successful:
The plant is very stable and delivers 25 kW of hot air
Heat losses are small and correspond to theoretical expectation,
Each of the 3 ventilators consumes less than 20 W (!)

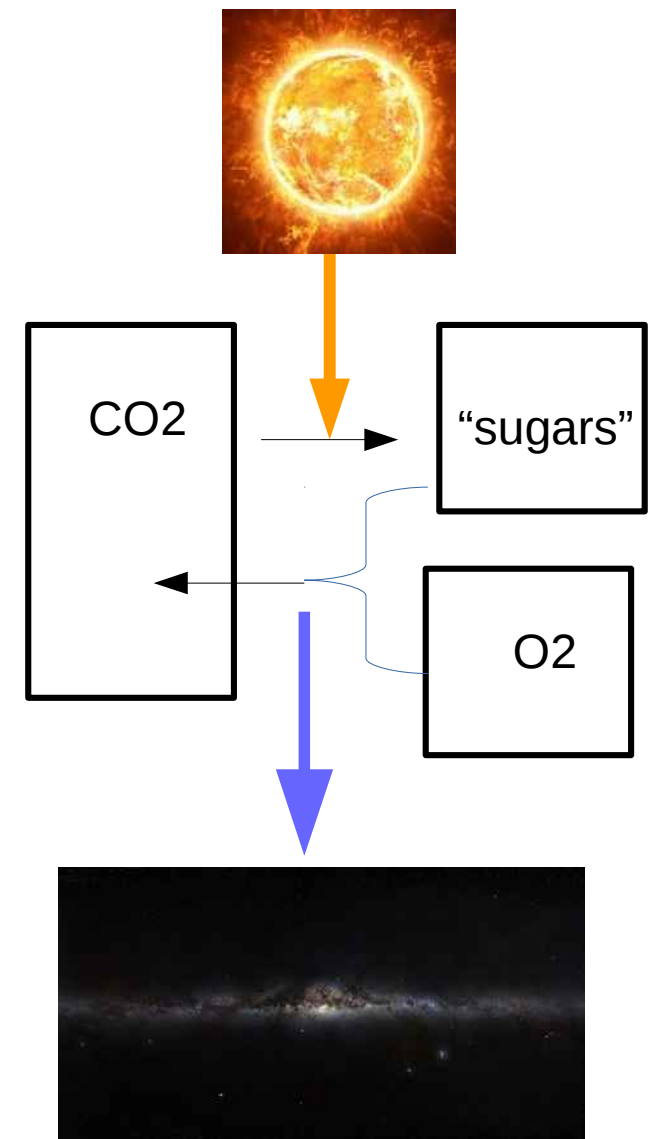
As a result we arrive at an evolutionary next step in the development of natural closed cycles:

Our ancestors 1.5 million years ago have learned to make better use of the closed cycles of nature

by learning to cook their food on fire
(homo erectus, cave Wonderwerk, Gesher Benot)(*)

This improved use of natural resources has contributed to the start of cultural evolution

(example potato: in order to eat it, one must first heat it to 100°C)



(*) *The energetic significance of cooking*, Rachel N. Carmody, Richard W. Wrangham, *Journal of Human Evolution*, Volume 57, pages 379-391

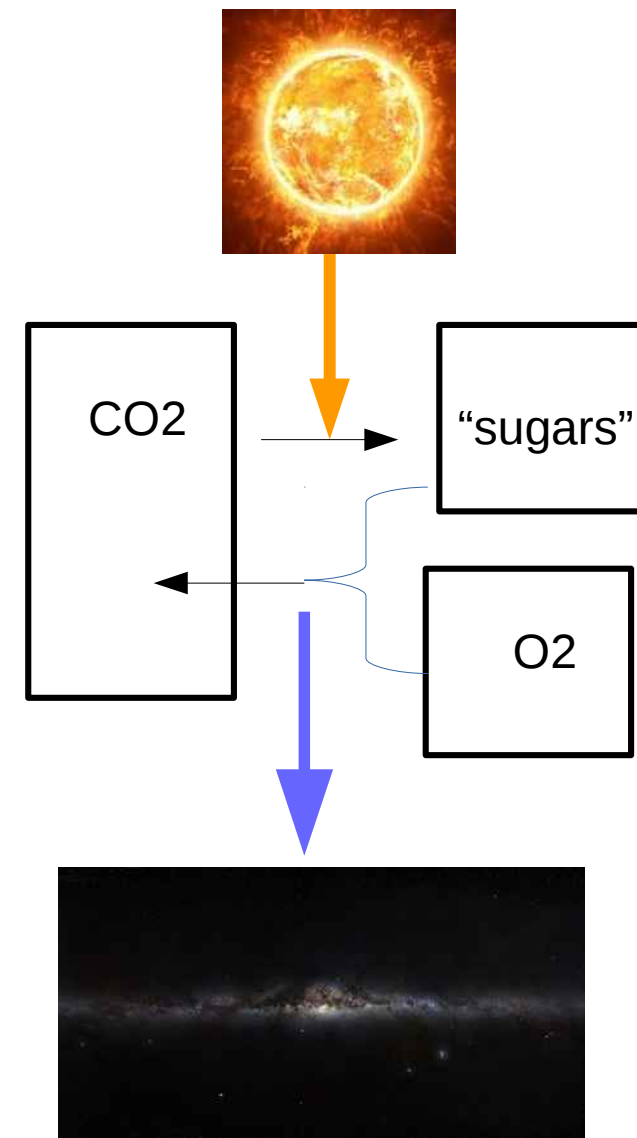
From a physics point of view, burning or digesting biomass is the same thing.

Therefore the new solar plant of A&T 2000
For the **preparation of CO₂ neutral combustibles**

Might be as important

As the first fire for the **preparation of food.**

Insofar as the potential is emerging, to bring the results of our cultural evolution in harmony with the resources of nature.



Future: Research

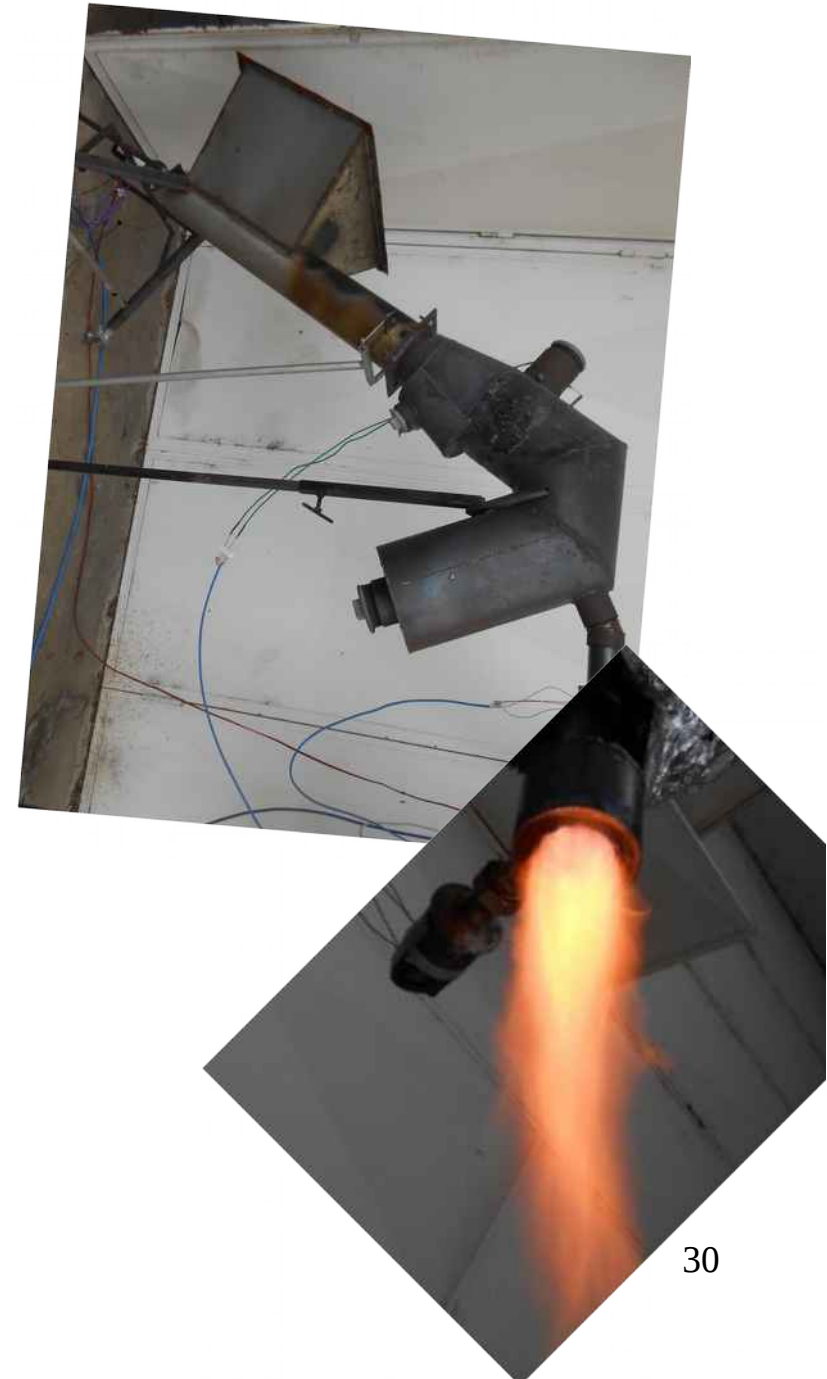
Study roasting of biomass and waste

Heat recovery

Linear Mirror III

Industrialization of the gasifier

New techniques of electricity production:
From a physics point of view
there is no big difference
between an Ariane rocket
and our gasifier....



Future: Research and Application

The Linear Mirror was developed by the accademic spin off Isomorp srl together with students, PhD students and post docs.

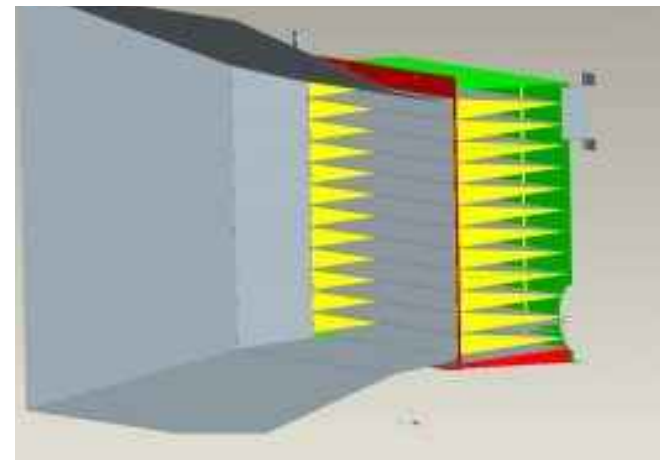
Collaboration between Isomorph srl and A&t 2000 works very well.

=> example for collaboration of fundamental science and industry

=> we need to extend thus successful model of collaboration to more companies, in order to speed up the transition from a fossil based to a solar based economy.

The Linear Mirror and its secondary technologies create new opportunities for everybody.

Last but not least: the production and subsequent Storage of solar carbon is a cheap and risk free Alternative to geo-engineering.



Future: ESOF

From the very beginning we have done fundamental research in contact with all parts of society and culture, also because this is a pre-condition for scientific creativity, and it is a way to overcome the present tension between technology, humanity and nature.



ESOF has a similar vision - multidisciplinary and open
Therefore working in the framework of ESOF is so important to us!

Future: Europe

In the current paradigm CO₂ production can be stopped only by sacrifice:

Less mobility, less consumption,
less income, more public spending,
entire industries are to be wiped out
(coal power plants,
internal combustion engine)

The current paradigm is based on
current technology.

Our technology is
Innovative, makes economic sense,
Is competitive with fossil fuels, can be integrated with existing technologies

Therefore it is able to stop global warming without creating poverty.
Rather it offers the chance of economic growth in harmony with culture and
nature.

Together with ESOF this approach could create a better future for Europe.

