Clean green hydrogen,
the fuel of the future that you can
order here today

Boh Westerlund
OAZER AB (OAZES Inc)
Umeå, Sweden
Clean green hydrogen,

a solution also for
arctic road transport
and energy storage

Boh Westerlund
OAZER AB (OAZES Inc)
Umeå, Sweden
Green hydrogen, the solution also for Arctic Road Transports

Boh Westerlund
BW Konstruktion AB / OAZER AB
Umeå, Sweden
By Al Gore
2006

an inconvenient truth
A GLOBAL WARNING

by far the most terrifying film you will ever see.

https://www.youtube.com/watch?v=I-SV13UQXdk

now playing in select theaters
A big part of the solution to stop climate change is Zero Emission transportation.
A part of the solution to stop climate change is Zero Emission transportation. That is Electric Vehicles (EV)
A part of the solution to stop climate change is Zero Emission transportation. That is Electric Vehicles (EV) Battery Electric Vehicles (BEV)
A part of the solution to stop climate change is Zero Emission transportation.

That is Electric Vehicles (EV)

Battery Electric Vehicles (BEV)

Fuel Cell Electric Vehicles (FC-EV)
This has been my focus for many years
Even in the Subarctics and Arctics
Battery Electric Vehicles (B-EV) are not well suited for the Arctics.
Winter tests proves that Fuel Cell Electric Vehicles (FC-EV) are much better suited for the Arctics
Basic principles for FC-EV
Basic principles for FC-EV
Basic principles for FC-EV
Basic principles for FC
Basic principles for FC
Our need for heating favors FC-EV
Fuel Cell Electric vehicles 2017

Fuel Cell Electric buses are now produced World Wide

Fuel Cell Electric trucks: Nikola Motors types ONE & TWO
Now also heavy FC-Trucks on the roads
We can and want to put heavy FC-Trucks on the roads in our areas
We can and want to put heavy FC-Trucks and not only for show in "snow"
For to really get Zero Emission transportation with electric vehicles, we need zero emission electricity

No more fossil power plants

No more bio-power plants
For to really get Zero Emission
We must stop burning coal!
For to really get Zero Emission
We must stop burning coal!

Last minute information:

The Keeling curve

KÄLLA: Delorme [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)]
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For to really get Zero Emission
We must stop burning coal!
The sustainable environmental cycle with hydrogen

Energy from nature

Electrolysis and Storage

Water back to nature

Refueling stations
The sustainable hydrogen cycle especially for the arctic region

Solar energy captured in summer  Electrolysis and  Hydrogen storage

Refueling vehicles  or:  Back to electricity  To the local grid
And hydrogen storage is the solution for grid balancing and energy storage. Also in the arctic region.

- Solar energy in summer
- Wind energy when blowing
- Electrolysis to $\text{H}_2$
- Hydrogen storage
- Back to electricity
- To the local grid
H₂ is the Solution not Batteries

- If storing surplus Renewable Energy for more than ~8 hours, hydrogen is clearly the winner.
- If hydrogen is used as a fuel for fuel cell vehicles or as raw material for industry, the advantages are even greater!

Energy Storage Costs
Hydrogen vs Battery ($/kWh)

- Hydrogen
- Battery

<table>
<thead>
<tr>
<th>Time</th>
<th>Hydrogen</th>
<th>Battery</th>
</tr>
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<tbody>
<tr>
<td>1h</td>
<td>$0.030</td>
<td>$0.025</td>
</tr>
<tr>
<td>4h</td>
<td>$0.099</td>
<td>$0.075</td>
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<tr>
<td>1wk</td>
<td>$0.127</td>
<td>$1.086</td>
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<tr>
<td>1M</td>
<td>$0.172</td>
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Contains Proprietary Information
The Hydrogen market trends

http://www.itm-power.com
The Hydrogen systems cost picture

ITM Electrolyser Cost Projections
- Expect system sizes to grow over time
- Larger scale enable cost reduction
- Larger volume enable efficiencies
- Continuous technology improvements
- Sensitive to scope of supply

<€1,000/kW today @ MW scale | <€800/kW @ 10MW | <€500/kW by mid 2020's

http://www.itm-power.com/
The Hydrogen systems are there to use, BIG & small,
The Hydrogen systems are there to use, BIG & small, but:
The challenge for all technology in the Arctic region is Cold climate adaptation.
The challenge for all technology in the Arctic region is Cold climate adaptation
The challenge for all technology in the Arctic region is Cold climate adaptation. But now also
The challenge for all technology in the Subarctic and Arctic is

Cold climate adaptation and

Hot climate adaptation
The challenge for all technology in the Subarctic and Arctic is

Cold days as -40°C and

Hot days as +40°C
The challenge for all technology in the Subarctic and Arctic is

But also rapid daily change.
The challenge for us all in the Subarctic and Arctic is:

**Climate Change**
The challenge for the whole globe is: Climate change!
But WE,
But WE, CAN,
But WE, CAN, ALL,
But WE, CAN, ALL, DO,
But WE, CAN, ALL, DO, something!
First subarctic Hydrogen Refueling Station: OAZER HRS in Umeå 2018

A project with Svevia, the road entrepreneurs
First subarctic Hydrogen Refueling Station: OAZER HRS in Umeå 2018

Where will the next come?
Arctic Regions H2 refueling & transport

• Filling station test in 2013: Arctic driving Center, Rovaniemi, Finland *(What happened here?)*

• Arctic Regions H2 transport: Scania & ASKO project Norway *(Happens now!)*

• Railway project, Norway *(Happens when?)*
Also the Arctic regions must adapt to this global technology shift

• The solutions are there:
  —to develop and,
  —to prosper on!
Arctic Region H₂ transport

What will be the next hydrogen project here?
This was my question in January 2017 at:

Boh Westerlund
BW Konstruktion AB / OAZER AB
Umeå, Sweden
This was my question in January 2017 at:

Safer, Smarter and Greener Arctic Road Transport

ARCTIC ROAD TRANSPORT CONFERENCE
11-13 JANUARY, IVALO, FINLAND

and it still stands unanswered. . .

Boh Westerlund
BW Konstruktion AB / OAZER AB
Umeå, Sweden
Thank you for your attention and future contribution to a Greener & cleaner World

Boh Westerlund
BW Konstruktion / OAZER / ECTM
Umeå, Sweden
bwk@telia.com

This presentation is sponsored by Uminova Innovation
Thank you for your attention and future contribution to a Greener & cleaner World

Please help save the world!

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Please help save the world!

And make some arctic business

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BW Konstruktion / OAZER / ECTM
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Extra info if requested:
Efficiency rules out the ICE

ICE = Internal Combustion Engine
Green hydrogen production

Green Hydrogen can be produced by:

• Electrolysing by green electricity from:
  – Hydro plants
  – Solar panels
  – Wind generators

• Biogas through reforming of biological waste
Energy storage needed

General energy storage:

- Hydro power = Water storage
- Battery storage
- Hydrogen storage

Cryogenic hydrogen storage for the Arctic regions?
Hydrogen & FC Hype Cycle

- Peak of Inflated Expectations
- Trough of Disillusionment
- Plateau of Productivity
- Slope of Enlightenment
FCEV roll-out (cars):
Many countries have come far with the roll out of hydrogen refueling stationer and FCEVs, especially:

- Japan
- Germany (400 stations 2020)
- USA

In Europe Germany is leading closely followed by England, Denmark, Norway and others.
Many countries have come far with the roll out of hydrogen refueling stationer and FCEVs, especially:

- Japan
- Germany (400 stations 2020)
- USA (300+ only by Nikola Motors)
Heavy E-Trucks
Heavy FC-Trucks