“How inappropriate to call this planet Earth when it is quite clearly Ocean.” Arthur C. Clarke
Ocean = solar collector + storage
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- 100% sustainable
- Continuous: day & night
- Scalable and enormous
- Competitive today
Around **100 countries** have access to Ocean Thermal Energy providing a billion dollar market opportunity.
<table>
<thead>
<tr>
<th>Company</th>
<th>Team</th>
<th>Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Founded in 2010, Offices in Delft (NL) and Aruba</td>
<td>Dedicated team of professionals, interns and graduates</td>
<td>Financial, legal, engineering, EPC construction, universities and equipment vendors</td>
</tr>
</tbody>
</table>
Bluerise
What we do

Project development
OTEC, SWAC, Ecopark (Curaçao, Colombia, Jamaica, others...)

Technology
More efficient, lower $/kWh

Software
Resource Assessment
my.oceanpotential.com

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SDC / SWAC
Seawater District Cooling / Seawater Air Conditioning
SDC / SWAC Benefits

- Lower energy costs
- Environmentally benign
- Less maintenance
- Plug-and-play
- Stable price – no volatility

Curaçao Airport Project
Hato Airport, Curaçao
Exclusive development contract for:

- 10MWt seawater district cooling
- 0.5MWe power plant

Hato Airport, Curaçao
Seawater district cooling network
Montego Bay, Jamaica

Seawater District Cooling
Montego Bay, Jamaica

- 21MWt seawater district cooling (~6450 households)
- 10x more efficient than regular air conditioning replacing 7 MWe for cooling and reducing 17,000 tons CO2 annually (~3600 cars)
- Costs savings up to 60%
How do we get to ARUBA +?

MANEHO DI ENERGIA SOSTENIBEL

Plan di accion pa resolve problemanan energetico actual:

- Implementa un manebo duradero y sostenibel encuantu energia, uso di awa, biento y solo pa bin cu energia alternativo.

- Instala e tecnologia di uso di awa friu (for di lama hundo) pa fria edificacionan ("cold water cooling"). Esaki lo nifica menos uso di electricidad pa edificio y a lo largo lo reduci gasto di aircio.
Island Energy: Aruba - 2013 energy balance

- Imports: 12,035TJ
- HFO imports: 8,090TJ
  - Electricity generation: 8,581TJ
- IC engine losses: 2,766TJ
- Diesel imports: 636TJ
- Propane imports: 486TJ
- End use energy for transport: 691TJ
- Industrial heating/cooling gas use: 328TJ
- Household heating/cooling gas use: 160TJ
- Cooling and A/C electricity use: 1,403TJ
- Lighting, appliances and other electrical uses: 1,227TJ
- Water production: 175TJ
- Electricity demand: 2,805TJ
- Grid losses: 536TJ
- Thermal Power Conversion losses: 5,240TJ
- Wind power produced: 491TJ

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~10% of electricity of Aruba is being used for cooling the hotels

85% depended on heavy fuels despite all efforts

>USD$20 million used to pay cooling in the hotel area

716,000 tons CO₂ emission for Aruba each year

+ Shift in tourism: guests looking for sustainable and unique experiences

+ infra advantage: Most hotels clustered on the north side of the island
Proven Technology

- District Cooling Systems have matured and are in operation for decades
- The technology is currently in use in many countries and its implementation expanding
- Examples can be found in the USA, Canada, Sweden, Denmark, Finland and The Netherlands.
- District Cooling systems are also operational in relatively harsh and sometimes remote environments like the UAE, French Polynesia or Qatar
OTEC
Ocean Thermal Energy Conversion
OTEC
Ocean Thermal Energy Conversion
OTEC Benefits – Ocean Thermal Energy Conversion

- Constant energy source
- No land requirements
- No visual impact
- “By-products”

Basic Technical Principle
Technology is ready
OTEC Projects around the world today
Trincomalee, Sri Lanka

10MW OTEC

Competitive electricity rates

75,000 tons CO2 savings/yr
Barranquilla, Colombia

• 10 MW OTEC for Barranquilla
• Study supported by the Dutch government (Partners for Water)
Foreseen Economics

- LCOE expected to be below USD$0.05/kwh when mature, unprecedented for baseload renewables.
- LCOE currently competitive with HFO/Diesel generation in islands.
- Economies of scale apply:
  - Larger systems → lower LCOE due to lower influence on pipe/platform and other aux costs on overall costs.
  - Technology maturity
Learning Curve

Wind and solar price decrease in time

**ONSHORE WIND LEVELISED COST ($/MWh)**

- **WIND COSTS HAVE FALLEN 50% SINCE 2009**

**SOLAR PV MODULE COST ($/W)**

- **MODULE COSTS HAVE FALLEN 99% SINCE 1976 80% SINCE 2008**

**Learning rate 19%**

**Learning rate 24.3%**

Note: Pricing data has been inflation corrected to 2014. We assume the debt ratio of 70%, cost of debt (bps to LIBOR) of 175, cost of equity of 8%. Source: Bloomberg New Energy Finance

Note: Prices are in real (2015) USD. 'Current price' is $0.01/W. Source: Bloomberg New Energy Finance, Maycock.
Comparing OTEC with solar PV

Main cost driver of OTEC is Heat Exchangers

**Solar PV module**
- Complex silicon structure
- ~35% of installed system cost
- Annual energy production 440 kWh/m²

**OTEC Heat Exchanger**
- Simple, thin (0.6mm) metal plate
- ~45% of installed system cost
- Annual energy production 1,000 kWh/m²
Deployment of the technology

- Implementation of SWAC/SDC projects is essential for tropical coastal cities to meet GHG reduction targets and provide stable prices. Cooling represents over half of current tropical electricity needs.

- OTEC technology can be de-risked by deploying smaller scale OTEC plants that are commercially competitive in combination with SDC.

- Standalone 10MW scale OTEC plants can be already be competitive with electricity generation in islands and isolated regions.
Roadmap

Power plant with District Cooling
0.25 MW
OTEC demonstrator in commercial cooling project
10,000 ton CO2 avoided per year

Power plant onshore
3 MW
Commercial demonstrator
15,000 ton CO2 avoided per year

Power plant offshore
10 MW
Commercial turnkey products
50,000 ton CO2 avoided per year

Power plant offshore
30 MW
Commercial turnkey products
150,000 ton CO2 avoided per year

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Important opinions

"OTEC is a clean energy source, a prime example on how to sustainably make use of our oceans without harming the marine environment."

Fabien Cousteau
Bluerise ambassador, oceanographic explorer and conservationist

"There is urgent need for our governments to mainstream OTEC within the sustainable development strategies for islands."

Dr. Devon Gardner
Head, Energy Unit
CARICOM Secretariat
‘EU of the Caribbean’
Thanks!

www.bluerise.nl
Energy storage (battery)

Constant source of electricity

How to ensure reliable energy supply?

Options available:

- Energy mix analysis – case: Curacao