



Company Presentation
November 2011





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Presentation Overview

1. Tocircle Industries AS

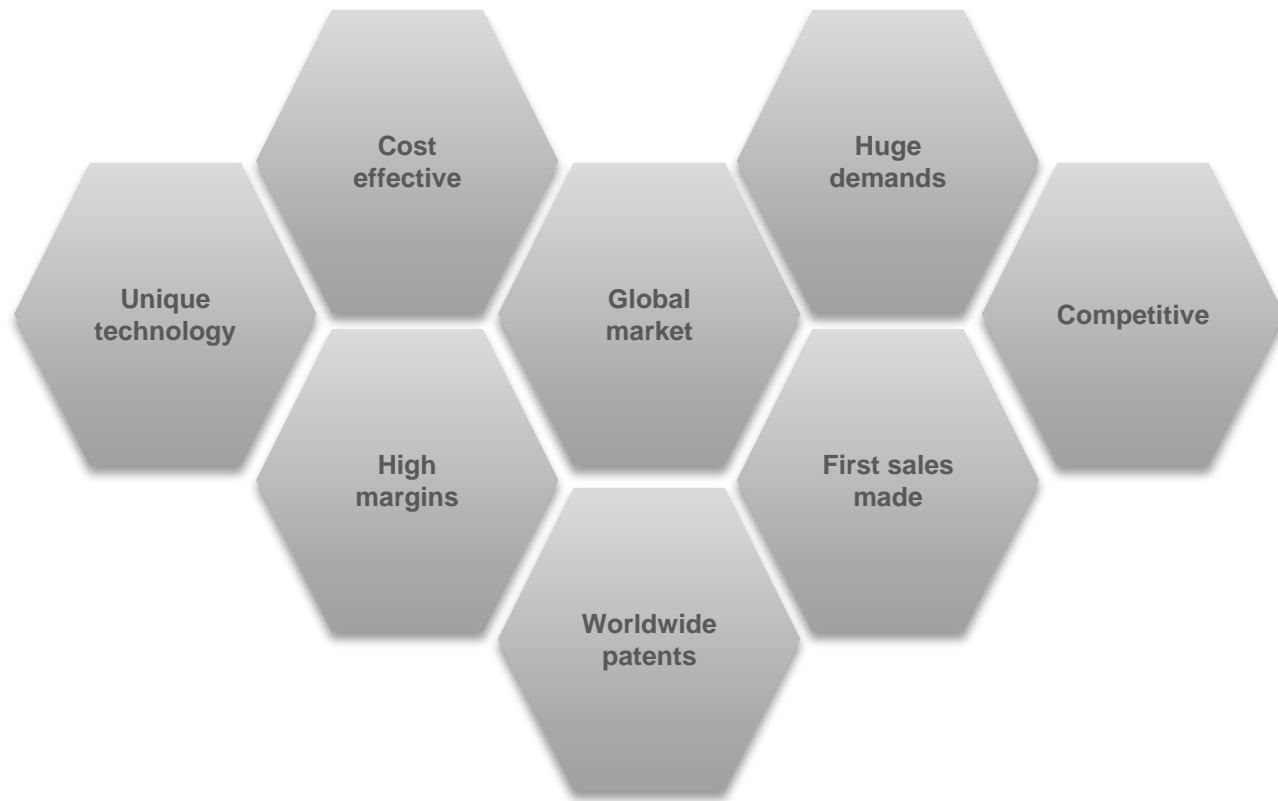
2. Cleantech Solutions

3. Pilot and results 2011



Tocircle - Investment opportunity

Tocircle Industries is a Norwegian Company that has developed a patented pump, expander/turbine, and compressor technology with the potential to significantly disrupt the numerous sectors it can be applied to by providing solutions for cleaner and more efficient utilisation of energy



Tocircle Industries

Introduction

Mega Trends

Technology in brief

Solutions

Team

Introduction

- Tocircle's **unique** geometric principle will **influence** development in pump, compressor and turbine/expander industries
- **Turbines/expanders** are used in most electricity production facilities around the world.
 - Electricity production from low temperature sources; both pressurized and thermal heat sources.
- The market for **pumps** is enormous. As much as **20%** of the world's electricity usage is spent on pumps and pump systems.
 - Pumps and compressors with unique high pressure and multiphase capabilities combined with robustness and efficiency

About Tocircle's technology

Knut Skårdalsmo
Statoil



"There are no contractual obstacles in this technology."

"The concept is too ingenious NOT to be commercialized."

Bjørn Kasin
Norwegian University of
Life Science



"Optimal mechanics."

"This will multiple the efficiency compared to today's technology."

Aligned with the Global Megatrends

Global Megatrends

- Megatrends reflect change processes, those that span decades. The global importance of **environmental protection**, **resource conservation**, and **climate protection**, is increasing all the time. These pressures combined with their time sensitive natures create immediate **demand** for new and more **efficient solutions**.

Tocircle's Contribution

- Tocircle's technology is emerging at the **right time** and brings "**the need for efficiency**"
- Focus on **energy recovery and effective energy production**, delivering **greater efficiency** in the global pump market
- The technology could provide **significant environmental improvements** to several industries

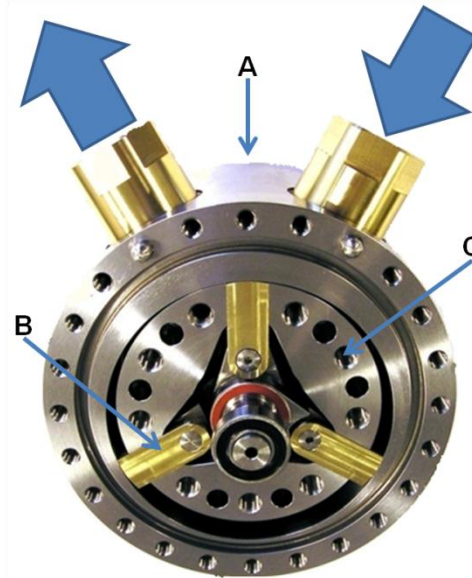
Conclusion

- This Norwegian developed technology has an **enormous potential**. It offers true **multiphase capabilities and scalability**.
- This patented pump/compressor/expander technology has the potential to **replace existing technologies** and **solve unsolved challenges**
- Tocircle has selected power and oil & gas as the first target markets for commercialization

Technology in brief

A flexible and robust rotating displacement machine

The unique geometric principle works in both directions



- A. A fixed cylinder works as the housing for the device.
- B. A rotating axis with three to seven fixed vanes is placed in the center of the housing. The vanes follow the inner wall of the housing with a constant (small) distance.
- C. A rotor, with a smaller radius than the housing, rotates eccentric relative to the housing. This creates a tapered space that is divided by the vanes. The increase/ decrease of the volume between the vanes creates the pump effect.

Prototyping and developments

- Tocircle has built approximately 50 prototypes with different configurations at their testing facilities.
- Focus has been on the core technology, and proving the uniqueness of the design.
- Friction, leakages, seals and bearings have all been thoroughly investigated.
- Different materials, both metals and plastics have been used.
- Variations in size, pressures and fluids have all contributed to current knowledge about the technology.
- **The technology has proven very efficient in pumps, compressors and expanders.**

Technology in brief

Unique patented technology with many opportunities

Unique technology and global patents

- Tocircle has an optimal machine based on a new geometric principle
 - Circular motions in all movements
 - Circular casings and cylinders with pressure or vacuum
 - All moving parts, gasses and liquid work and move in the same direction
- Tocircle delivers pumps, compressors, expanders and turbines*
- Tocircle holds all rights to “global” patents for the technology

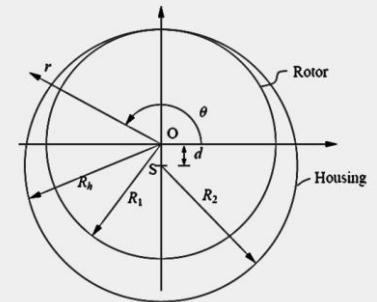
**Going forward in the presentation; turbines and expanders will both be referred to as expanders*

Main technology features

- Ability to operate at very high pressure
- Handles any mixture of gas and fluids (multiphase)
- Uniquely simple design
- Easy manufacturing and mass production
- Highly scalable products
- High energy efficiency and reduced emissions
- Endurable and reliable products
- Very low noise level and vibration

Core technology is ready and verified

- Tocircle has invested 10 MUSD over several years testing and proving the core technology
- Several third parties have verified the technology and its potential
 - Statoil
 - UMB (Norwegian University of Life Science)
 - Ricardo (Global multi-industry engineering provider)



Tocircle geometric principle

Tocircle Industries AS holds all rights to a patented technology on a rotary machine based on a new geometric principle which improves traditional displacement machines significantly.

Turbines and turbo expanders

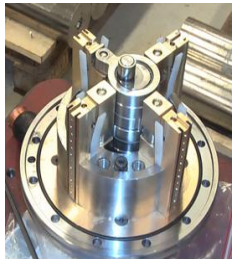
The outcome of this technical innovation are the following three products:

Pumps



- The Tocircle pump is self-priming and able to handle any gas/liquid mixture. It is therefore well suited for pure multiphase applications and applications where the pumped media is close to its bubble point, such as liquefied gas pumping.
- The pump has proven high differential pressures capabilities and endures “slugs” in its nature.
- Due to its compact design it can very well serve as a vacuum pump, lube oil pump, cooling water pump, condensate pump, glycol pump as well.

Compressors



- The ability to handle a wide range of gas compositions, gas/liquid mixtures, slugs and varying inlet conditions, along with its robustness and low maintenance requirements makes the Tocircle compressor well suited for mixed fluid compression. E.g compression of associated gas (flare gas recovery units) and vapor recovery units.
- With practically no vibrations and pulsations, low lubrication demands and high pressure capabilities, the Tocircle compressor can also be a superior alternative to both reciprocating and screw compressors in applications such as boil of gas compressors, refrigerant compressors, compressors for nitrogen generation plants and booster compressors, eliminating the need for pulsation dampeners and reducing the need for downstream lubricant separation equipment.

Turbines and expanders



- Electricity generation from waste heat using traditional turbines suffers from low efficiencies, as their optimum operating temperature is 300-600 degrees Celsius, considerably higher than much of the waste heat resource.
- The real multiphase capabilities of Tocircle’s turbine/expander, its reliability & low maintenance cost, and reduced up front investment cost, make it ideal for waste heat recovery using direct steam expansion and Organic Rankine Cycle systems.
- Furthermore, these multiphase capabilities also make it ideal in oil & gas applications in for example cooling/liquifaction applications, either in cascade systems or for direct expansion of compressed cargo vapor.



Tocircle technology compared

A highly respected independent consulting firm has compared the Tocircle machine with the most common pumps, expanders and compressors.

	Tocircle machine	Centrefugal pump	Lammela pump	Turbo Expanders	Compressors
<i>Efficiency</i>	A	C	B	C	C
<i>Efficiency at varying RPM</i>	A	C	B	D	D
<i>Maximum capacity</i>	A-	A-	B+	A-	A
<i>Capacity at low RMP</i>	A	B	A	B	B
<i>Capacity at variable RMP</i>	A	B	A-	B	B
<i>Internal leakage</i>	A	B	A	B	B
<i>Multiphase</i>	A	B	A	B	B
<i>Mud</i>	A	B	A-	F	F
<i>Cavitation</i>	A	B	A	B	B
<i>Compression</i>	A	F	F	F	B

A = Best
F = Unable to perform

Tocircle Industries

- Introduction
- Mega Trends
- Technology in brief**
- Solutions
- Team

Tocircle solutions and applications

Cleantech Solutions

Power Systems

- Steam power plants (multiphase)
- Organic Rankine Cycle (ORC) solutions
- Hydro power



Water Systems

- Energy recovery from reverse osmosis (desalination of water)
- High pressure water pumps
- Water infrastructure boosting
- Sewage pumps



Engine Systems

- Combustion engine
- Green fuel engines
 - Bio fuels
 - Methanol
 - Ethanol
 - Hydrogen



Oil & Gas Solutions

Petroleum Systems

- High pressure oil pumps
- High pressure compressors
- Mixed fluid gas compressors and expanders
- Multiphase and boosting pumps
- Mud pumps
- High reliability general application pumps
- Expanders for pressure reduction (wellhead)
- Subsea and deep water applications



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Tocircle Team

Solid management and a versatile and experienced board of directors

Board of Directors



Dr. Øivind Lund – Chairman

Dr. Lund has broad international industrial experience, having held the position of President and Country Manager of several of ABB's operations around the world. He holds an MSc and a Ph.D. degree in Electrical Engineering from the Norwegian Institute of Science and Technology and a degree in Industrial Economy from BI Norwegian School of Management. In addition to his post as Chairman with Tocircle, Dr. Lund is Chairman of the Board of Yara International ASA (the world's leading mineral fertilizer supplier) and Marine Accurate Well (Maracc) ASA.



Knut Anton Heim – Member of the Board

Mr. Heim has many years of experience from business strategy. He has been CEO for HMC Norge AS, De Groot International Contractors Norge AS, and several companies in the Heerema Group. Since 1999, he has been a consultant to the petroleum industry. Mr. Heim holds a M.Sc. in Mechanical Engineering from University of Michigan, USA.



Snorre Dahle – Member of the Board

Investor and business developer. Broad experience from a number of successful investments in industry and real estate. Over 30 years experience as investor.



Merete Lütken – Member of the Board

20 years experience as director of marketing and communication in several well known Norwegian companies. Presently a management consultant with focus on business strategies, communication and innovation. Board member in several companies within technology, health, education, media and industry.

Management



Ellef Kure – CEO

With a focus on oil and gas, Mr. Kure has been working within consulting and technology for more than 14 years. He has large scale project management experience from major Norwegian companies such as Statoil, Aker Kværner, Aker Engineering and Telenor. Mr. Kure holds a M.Sc in Mechanical and Systems Engineering from Norwegian University of Science and Technology and a Master of Management degree from BI Norwegian School of Management.



Frank Nylænde – CFO

Eight years from management with Price Waterhouse Coopers. Six years from top management with Renolit Norge AS, two of the years as CEO and four years as CFO. Manager of Provida AS. Mr. Nylænde is a state authorized accountant and has his degrees from the Norwegian School of Economics (NHH) and BI Norwegian Business School.



Erik Hartvig-Larsen – Business Developer

Mr. Hartvig-Larsen has an extensive career in top management in finance, industry and project management, both with public and private companies. Mr. Hartvig-Larsen holds a Civil Economist degree from Universität Erlangen-Nürnberg in Germany.



Per T. Rødland – Business Developer

Has many years of experience in finance from of leading investment banks and financial consulting firms. He has top management experience from finance, IT and marketing. Mr. Rødland holds a MBA degree with a finance concentration from CLU School of Business, USA.



Tocircle Team

Highly experienced Technical Personnel

Tocircle Industries

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Key Technical Personnel



Dr. Bjørn Hånde – Director of Technology

Specialist in rotating machinery, compressors and gas turbines. 18 years experience from offshore engineering projects. Background from development of compressor design and simulation tools. Leading condition monitoring specialist in several larger oil and gas projects. Certified GE Six Sigma Black Belt. PhD in Mechanical Engineering from the Norwegian University of Science and Technology: Dynamic Simulation of Steam Injected Gas Turbines, MSc from Stanford University, USA, Smart Product Design.



Hans Nicolai Slettebø – Lead Engineer

Mr. Slettebø has many years of experience from rotating machinery, pumps, heat exchangers, pressure vessels, valves, piping, structure and layout. He has been 10 years with the Hamworthy Group, working for the pump system division, the gas system division before he became division manager for Hamworthy Oil & Gas. Mr. Slettebø has a MSc in Mechanical Engineering from the Norwegian University of Technology and Science.



Dr. Laurent van Overberghe – Development Engineer

Dr. van Overberghe worked two years as a process engineer at Renault in France. Before joining the Tocircle team he worked two years for REC Wafer Norway as a technologist and later project manager. Dr. van Overberghe hold a PhD in Material Science from Ecole des Mines de Paris, Centre for Material Forming, France and a MSc in Mechanical Engineering from Ecole Polytechnique de Louvain, Belgium.



Pål Reinertsen – Development Engineer

Mr. Reinertsen has designed and produced several new prototypes and designs based on the Tocircle principle. He is a skilled design engineer and holds the responsibility for expanders applications. Mr. Reinertsen has a degree from Gjøvik Mechanical School.



Kjell W. Vading – Inventor and Technical Consultant

Mr. Vading is an inventor with over 40 years developing machinery solutions. Mr. Vading has delivered solutions for Skanska, Selmer, Veidekke, and Norcem. He holds a degree in Mechanics from the University of Stavanger.



Harald Nylænde – Inventor and Technical Consultant

Mr. Nylænde is a mechanical problem solver and inventor. He has spent his career designing, investigating and solving complex mechanical challenges. He has founded an Norwegian inventor forum and built several combustions engines. Mr. Nylænde has in depth knowledge about hydrogen processes, reversed osmoses and hydro power plants.



John Lee Cotton – Technical Consultant

Mr. Cotton is a rotating machinery expert with extensive experience from top tier engineering companies such as General Motors, Kongsberg Våpenfabrikk, Kværner Engineering, Kværner Energy, and General Electric Thermal Power. He has specialized in planning and specification of rotary machinery for several offshore platform projects as well as working on design and production of subsea multiphase pumping stations for major oil companies. Mr. Cotton holds a MSc. in Mechanical Science from Cambridge University, England.

Cleantech Solutions

Capitalising on the paradigm shift from waste to commodity

Challenges

- Global energy demands are outpacing supply.
- Electricity is the fastest growing end-user source of energy.
- More than 50% of energy used globally is released as waste heat and thus not utilised.

New macro agenda

- Waste heat is increasingly thought of as energy resources and material commodity
- This is driving technological innovations and alternative market tools
- Markets are experiencing unprecedented interest from investors, and are poised for sustained growth
- Turning waste heat into usable electricity power enables e.g. power plants, industrial plants, ships, etc. to improve margins considerably and reduce their carbon footprint



EU has issued several directives designed to improve regional energy security and combat global climate change.



The US congress extended the Treasury Grant Program for combined heat and power in December 2010.



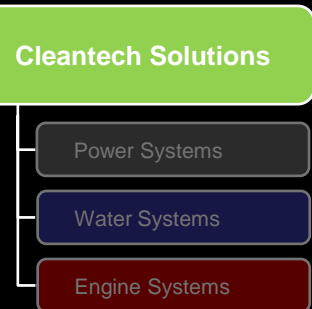
The Chinese Environment Minister wants to see environmental protection become a key plank of the new Five Year Plan (2011-2015).





Markets and Application Areas

Tocircle's first target market is Power Systems. Within this they are focused on **Direct Steam Expansion (DSE)** and **Organic Rankine Cycle (ORC)** systems.



		Cleantech Solutions		
		Power Systems	Water Systems	Engine Systems
Application areas		<ul style="list-style-type: none"> • Direct steam expansion (DSE) • Organic Rankine Cycle (ORC) • Second stage turbines 	<ul style="list-style-type: none"> • Energy recovery for reversed osmosis-applications • Water pressure energy recovery units • Efficient high pressure and boosting pumps 	<ul style="list-style-type: none"> • Combustion engine • Green fuel engines <ul style="list-style-type: none"> ○ Bio fuels ○ Methanol ○ Ethanol ○ Hydrogen
Markets		<ul style="list-style-type: none"> • All waste heat sources • All power plants <ul style="list-style-type: none"> ○ Nuclear ○ Hydrocarbon ○ Geothermal/Bio ○ Solar steam • Marine • All foundries and industrial plants • Garbage incineration plants 	<ul style="list-style-type: none"> • Reverse osmosis <ul style="list-style-type: none"> ○ Desalination of seawater ○ Semiconductor industries ○ Pharmaceutical industries • All water utilities 	<ul style="list-style-type: none"> • Industrial • Transportation • Recreational products • Unmanned aerial vehicles/drones • Utility

Direct Steam Expansion

It pays to go clean

Cleantech Solutions

Power Systems

Water Systems

Engine Systems

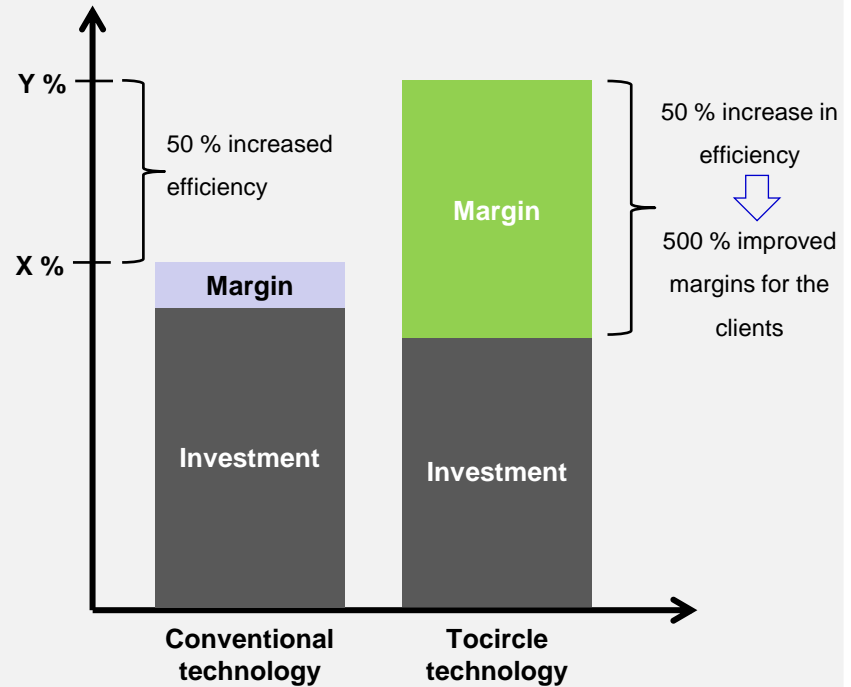
The unique technology

- High pressures
- Multiphase expansion
- High energy efficiency
- Simple, enduring and reliable
- Easy to mass manufacture
- Highly scalable
- Low noise level and vibrations

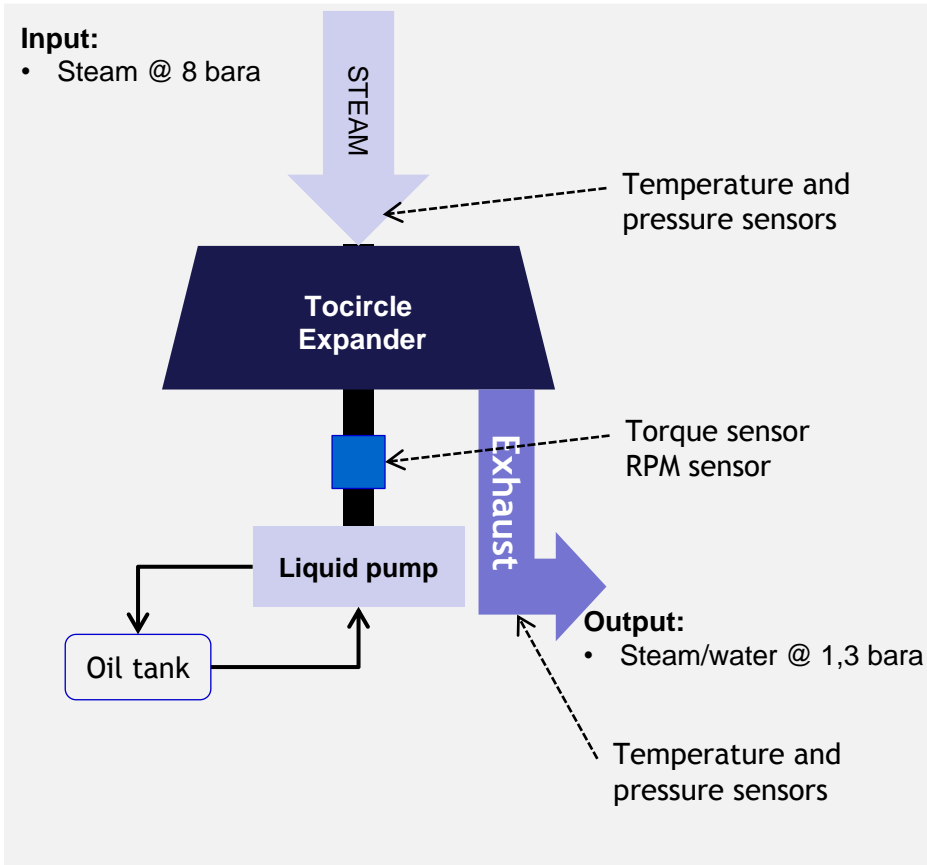


Improved margins

Efficiency



Expander test summer 2011 - the test setup



- The Tocircle expander has greatly improved the economical aspects for systems with steam also in the lower temperature ranges (120 - 300 degrees Celsius).
- Tocircle has developed a expander with matchless multiphase capabilities. The multiphase properties for the expander are crucial for efficient production of electricity.
- These properties allow for pressurized steam to expand converting this energy to electricity through a generator.

...building a 400 kW expander

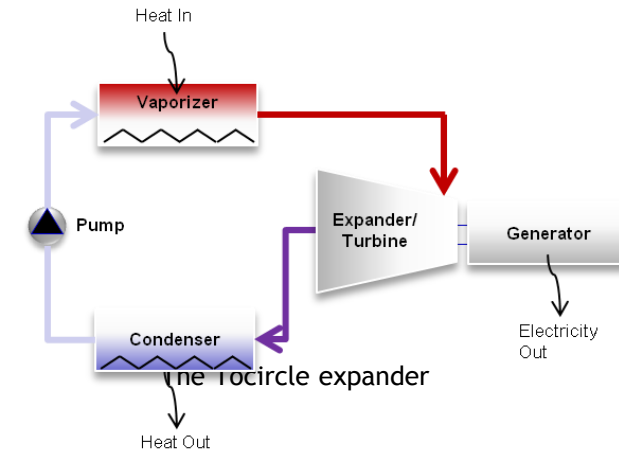
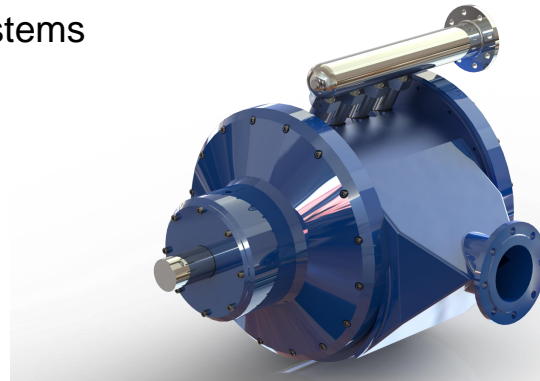
Steam expander built for customer 2011

Main design parameters

- Active chamber: $\text{Ø}500$, d500
- Rpm: 1200 - 1500
- Expansion rate: 1:6
- Tin: 160-220°C
- P in: 10-20 bara, P out: 1-3 bara



- The unique characteristics of the Tocircle expander result in significant advantages when applied in ORC systems:
 - Dramatically improved efficiencies (30-50 %)
 - Reduced investment cost and simplified systems.
 - High reliability and low maintenance cost.
 - Scalable to different sizes and environments.
- The know-how, competence and development team used in the direct steam expansion projects can easily be transferred to ORC systems



Standard ORC schematic



Company Presentation

Thank you!