MTT micro turbine / CHP development program

Status
&
Challenges

12 May 2015

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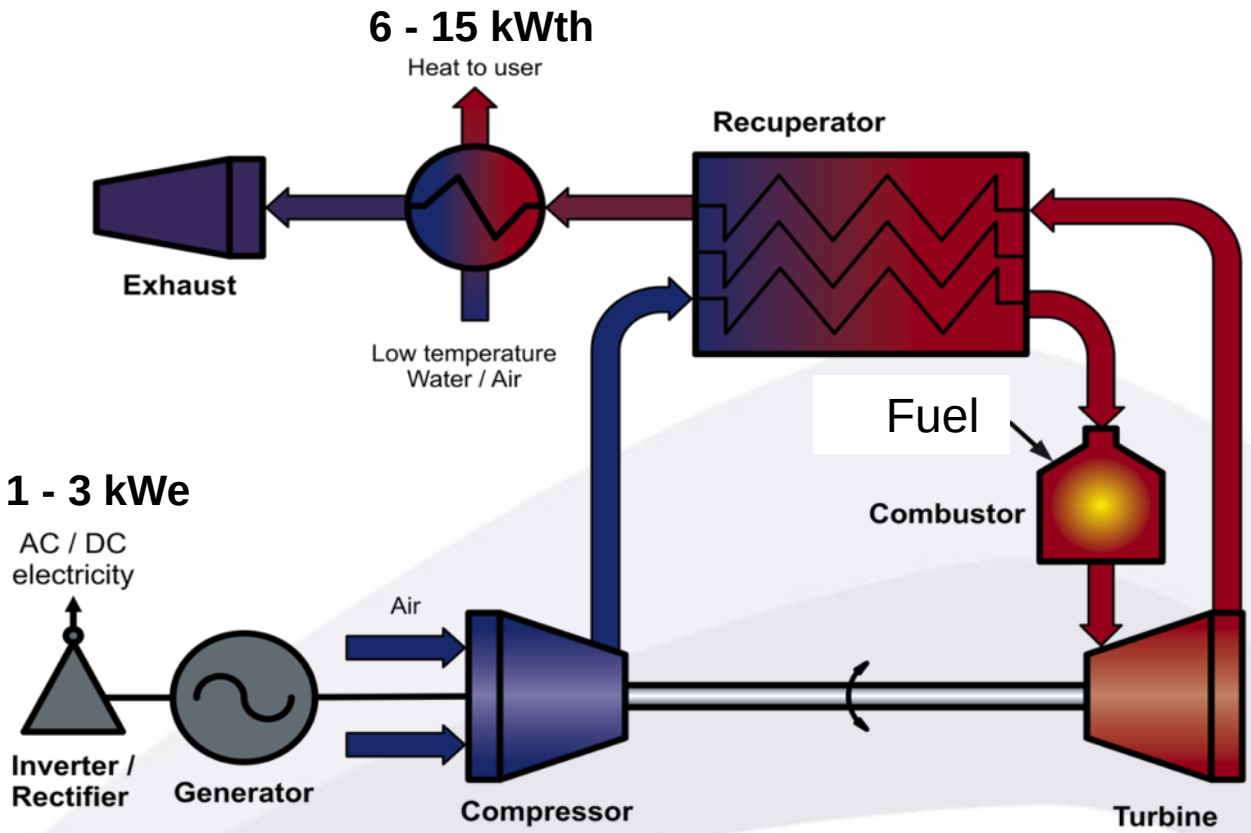
Outline

- Introduction
- EnerTwin micro CHP system
- Development program
- Technical Challenges
- EU cooperation

Introducing MTT

- **MTT is developing micro turbine technology since 2006**
- **Development of micro turbine based CHP (combined heat power) systems started 2008**
- **MTT is located in Eindhoven Netherlands, and currently employs 16 highly qualified staff**
- **Management team:**
  - Willy Ahout, CEO
  - Wilfried Visser, CTO
  - Luc Hamilton, COO
- **To develop and commercialize its CHP products, MTT has risk sharing contracts with various relevant industrial partners and with knowledge institutes**
- **Together with its partners, ± 45 skilled engineers work on the development of advanced MTT micro turbine technology**

Recuperated 3 kWe gas turbine CHP system



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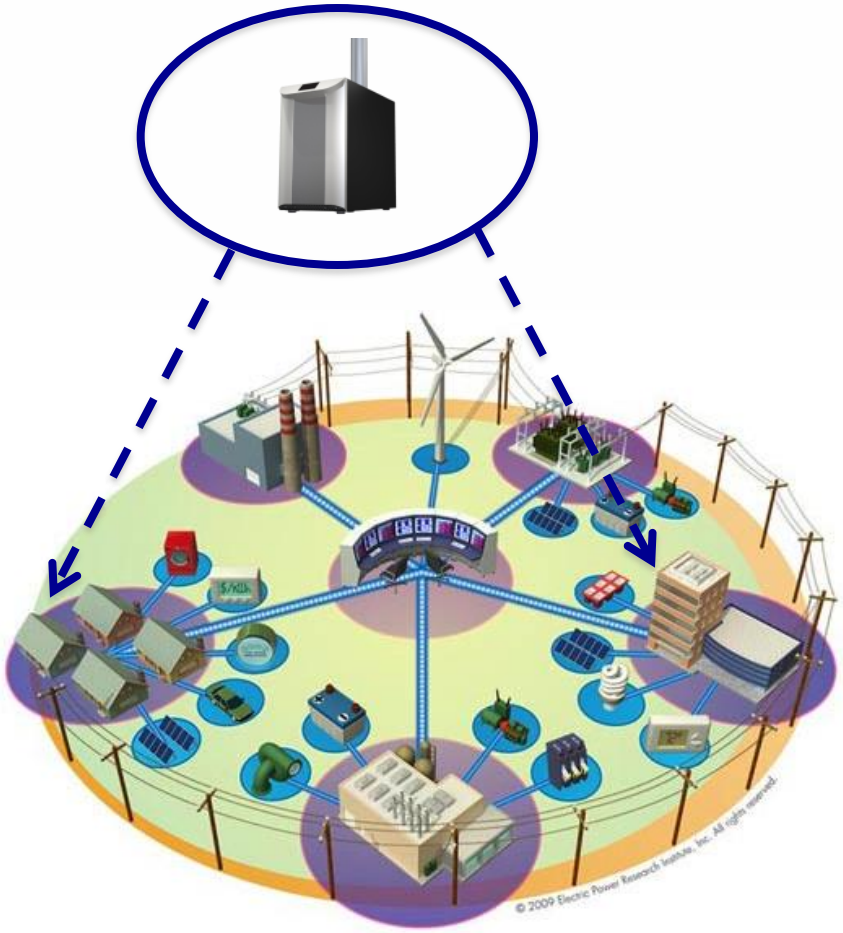
Micro CHP applications

- ***For consumers / SMEs:***
  - Substantial lower energy bills (up to 20-25%)
  - Environmental friendly
- ***For governments (national / EU):***
  - CO_2 and NOx emissions reduction, substantial energy savings
  - New economic activities and impulses
- ***For energy companies (utilities):***
  - Reduced needs for high investments in new power plants
  - New business models, green image, emission reductions
  - Decentralized generation / smart grids



EnerTwin target specifications

Specifications for the EnerTwin micro CHP system

- Power (natural gas) input 20 kW
- Thermal power 15 kW
- Electrical power 3.0 kW
- Net electric efficiency 15 %
- Power to Heat ratio 20 %
- Total efficiency 90 %
- Weight 225 kg
- Clean combustion < 37 ppm NOx
- Substantial CO2 reductions 3 - 6 tons per year
- Low noise < 55 dB(A)

Modulation range:
Heat : 6 – 15 kW
Electricity : 1 – 3 kW

Additional specifications:

- Able to modulate down to ~30 %
- Maintenance > 5,000 hrs (± 2 years, similar to condensing boilers)
- Lifetime > 30,000 hrs +
- Remote control / smart grid ready

Development program

- **2008-2009 3kW micro turbine cycle design study**
  - Based on knowledge obtained from general experience, literature
  - General state of the art performance/efficiency levels
  - Public turbocharger component performance maps

  ASME paper GT2010-22007 or J_GTP-133-2011
- **2009-2011 MTT micro turbine and CHP system development**
  - Test programs, detailed modeling analysis
  - Expanded technical team
  - New bottlenecks and new potential identified
  - Performance enhancement program

  ASME paper GT2012-68685
- **2012 MTT CHP system engineering and prototyping**
  - 1st field test phase (12 units)
- **2015 Engineering / Design for manufacturing**
  - Improved performance, life and reliability
  - Reduce costs
  - 2nd field tests phase (up to 50 units)

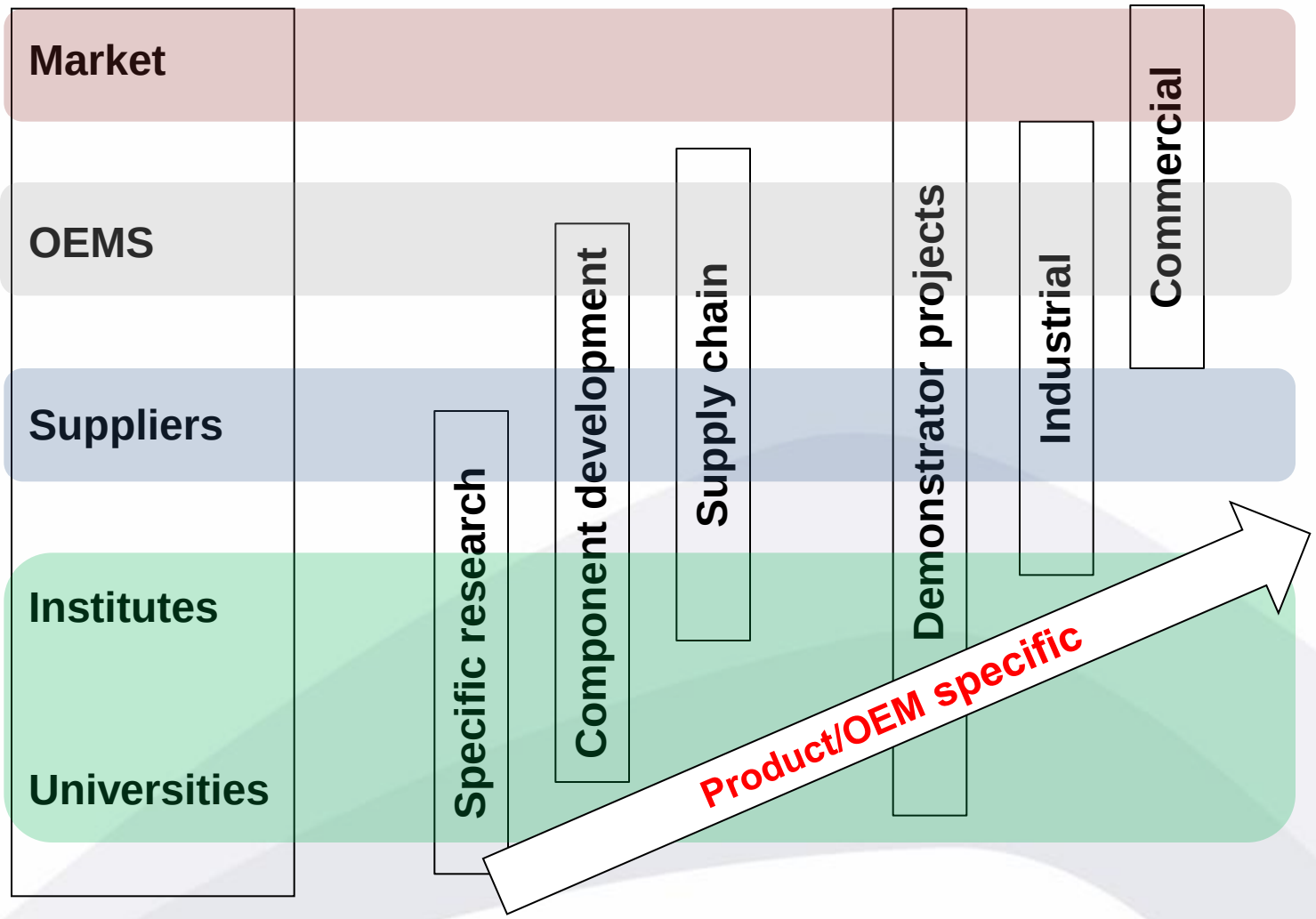
  ASME paper GT2015-42744

Micro turbine technology

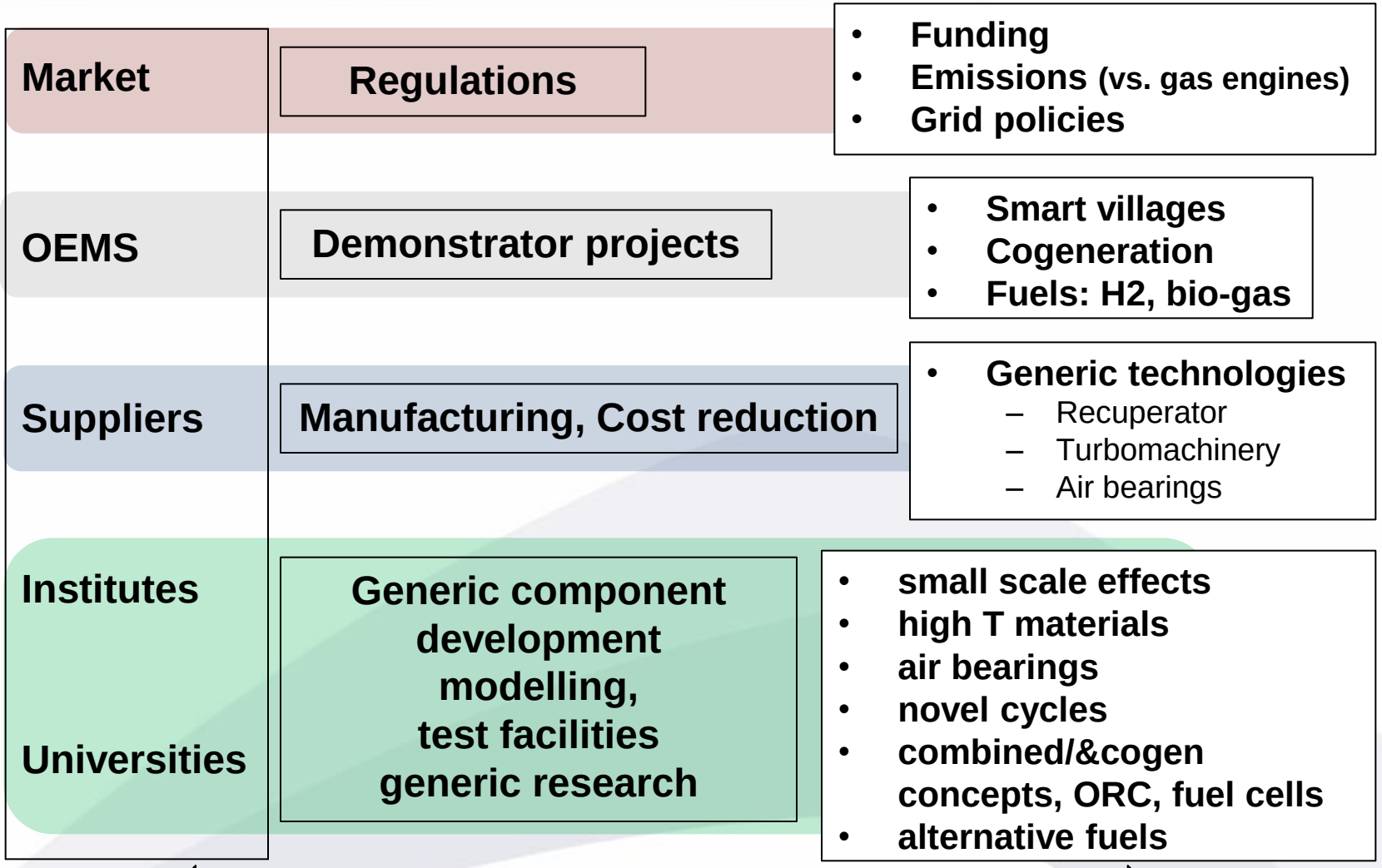
- **Micro turbines**
  - < 100 kW
  - Increasing number of interesting applications
    - Power generation
    - Aircraft propulsion
  - Many development projects failed

- **Challenges**
  - Small scale effects
    - Low Reynolds number
    - Relatively large tip clearance
    - Large area-volume ratio
    - High auxiliary system losses
    - Thermal management
  - Market & Cost issues
    - Require large production volumes
  - Recuperator
    - High temperature
    - Low costs
  - Low NO_x stable combustion - *(potential is < 10 ppm)*
    - Multiple fuels
  - Rotor dynamics

EU cooperation - Vertical



EU cooperation - Horizontal



EU cooperation – H2020 funding

	Vertical (specific)	Horizontal (generic)
System level		
Combined / bottoming cycles (ORC)	X	
Cogeneration (CHP)		X
Scaling studies	X	X
Component technologies		
Low cost high performance/high temperature recuperator	X	X
Turbomachinery	X	X
Manufacturing technology	X	X
Materials		X
Alternative fuels		
Bio gas, H2	X	X
Demonstrator projects		
Combined cycle/system demonstrators, ORC, fuel cell etc.	X	X
Small scale distributed power, smart villages		X
Optimized operation & utilization	X	
Other applications (e.g. UAV, portable power)	X	

Publications

- Visser W.P.J., Shakariyants S.A. , Oostveen M. **'Development of A 3kW Micro Turbine For CHP Applications'**, ASME paper GT2010-22007, presented at the ASME TURBO EXPO 2010, 14-19 June, Glasgow, UK
  Also published in ASME Journal of Engineering for Gas Turbines and Power, April 2011, Vol. 133 / 042301-1

- Visser W.P.J., Shakariyants S.A. , Later M.T.L. de, Ayed A.H., Kusterer K., **'Performance optimization of a 3kW Micro Turbine For CHP Applications'**, ASME paper GT2012-68686, to be presented at the ASME TURBO EXPO 2012, June 11-21, 2012, Copenhagen, Denmark

- Head A., Visser W.P.J., **'Scaling 3-36kW Microturbines'**, GT2012-68685, to be presented at the ASME TURBO EXPO 2012, June 11-21, 2012, Copenhagen, Denmark

- Kornilov V.N., Shakariyants S.A., Goey L.P.H., **'Novel Burner Concept For Premixed Surface-stabilized Combustion'**, GT2012-69036, to be presented at the ASME TURBO EXPO 2012, June 11-21, 2012, Copenhagen, Denmark

- Visser W.P.J., Dountchev I.D. **'Modeling Thermal Effects on Performance of Small Gas Turbines'**, ASME paper GT2015-42744, to be presented at the ASME TURBO EXPO 2015, June 15-19, Montreal, Canada

- Duijnhouwer F., Nijmeijer H. **'Modelling and simulation of a compliant tilting pad air bearing',** Journal of Mechanical Engineering Science, 2015

- Borisavljevic, A.; Brands, M.; Lomonova, E., **"Vector control of very-high-speed PM machines,"** *Electrical Machines (ICEM), 2012 XXth International Conference on* , vol., no., pp.2462,2468, 2-5 Sept. 2012

- van Meijl, W.; Muisers, G.; Borisavljevic, A.; Brands, M.; Lomonova, E., **"Sensorless observation of a very-high-speed permanent magnet synchronous machine,"** *Sensorless Control for Electrical Drives and Predictive Control of Electrical Drives and Power Electronics (SLED/PRECEDE), 2013 IEEE International Symposium on* , vol., no., pp.1,8, 17-19 Oct. 2013

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