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*Finland's Green Energy
Technologies and
Collaboration Opportunities*

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Finland – Taiwan Business Forum
April 25, 2016



FINLAND IS

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1st

- Qualified engineers
- Information technology skills
- Development and application of technology
- Funding for technological development
- Public and private sector ventures

1st

IN INNOVATION***

1st

GREENEST COUNTRY

Finland is the greenest country in the world 2016. The environmental performance index (EPI)**

2nd

IN CLEANTECH

Finland was ranked number 2 in both the Global Cleantech Innovation Index and EU Eco-innovation scoreboard 2013*

*WWF and Cleantech Group

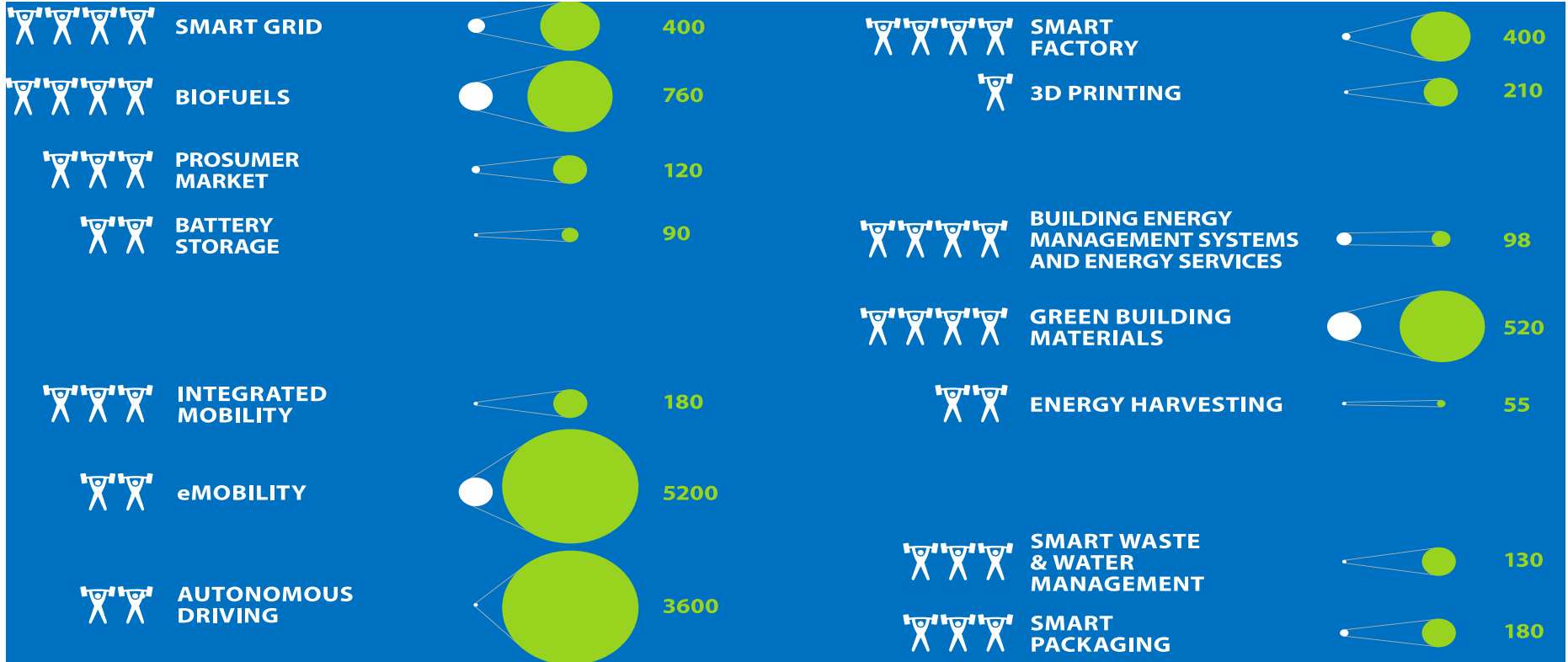
** Yale and Columbia universities along with the World Economic Forum.

*** The World Economic Forum, Global Competitiveness Report 2014 - 2015.



Global cleantech markets and Finnish strengths

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Source: Sitra Studies 102 (Frost & Sullivan)



Finnish companies offer world-class solutions in bio and waste-to-energy

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Bioenergy

- Co-production of electricity and heat (CHP)
- **New technologies to refine biomass into biofuels**
- Advanced forest management, wood harvesting and transportation chain

Waste-to-energy

- Waste-based fuel production
- Technologies for power plants to utilize waste as feedstock - particularly those involving FBB and CHP technologies



Service packages

Top 3 Finnish expertise packages:

- 1) Co-production of heat and power (CHP)
- 2) **Fuel production from biomass and waste**
- 3) Advanced forest management, wood harvesting and transportation chain

Additional service packages:

- 4) Biomass and waste processing
- 5) Biogas production & sludge treatment



St1 is one of the world's first and

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leading waste-based fuel producers

- The Finnish energy company St1 is a pioneer in waste-based ethanol production and production technologies. The company was **first in the world to produce bioethanol from food waste.**
- St1 technology can utilize a wide variety of waste:
 - Biowaste from households
 - Leftover dough from bakeries
 - Expired bread and other organic waste from shops
 - Waste from beer and other beverage production
 - Waste and process residues from confectionery production
 - Starch- and sugar-containing waste from the food industry
- Furthermore, St1 is currently building the world's first facility to produce cellulosic ethanol from sawdust.
- The company argues its small biofuel production plants are more economical than larger ones, as their locations at or near the sources of food waste mean that less transportation, equipment and energy per liter of product is needed.





Biodiesel from waste oil

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- BioGTS Biodiesel is an innovative, new technology for biodiesel production with zero consumption of water. This is a significant advantage especially in areas with water scarcity, since conventional techniques consume 3–4 m³ clean water / m³ biodiesel produced.
- The solution is scalable to 2,000–50,000 L biodiesel / day, and has a high production capacity with a short payback period of 2–3 years.
- The reactor design is based on cost-efficient container-shaped reactors. The compact reactors require little surface area, enable quick “plug-in” -installation and start-up, are easy to scale up and can be inexpensively transported. The process is continuously operated and fully automated.





Biofuels reference cases

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- Major forest and energy companies such as UPM, Fortum, Neste Oil and St1 lead the development, but medium-sized and startup companies operate as specialists in the biofuel ecosystem
- A bio-oil plant integrated with Fortum's combined heat and power (CHP) plant in Joensuu, Finland, was commissioned in autumn 2013. The bio-oil plant utilises fast pyrolysis technology and is the first of its kind in the world on an industrial scale.
- UPM opened the world's first wood-based renewable diesel biorefinery in Lappeenranta in January 2015. The facility produces UPM BioVerno biodiesel out of crude tall oil, a residue of pulp production that mostly comes from UPM's own pulp mills.
- Neste became another pioneer by providing renewable aviation fuel for Oslo Airport Gardermoen, which is the first airport in the world to offer airlines green fuel.



*UPM's biorefinery
Lappeenranta, Finland*



*Neste's biorefinery
Porvoo, Finland*



Smart and Clean Helsinki

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- The Helsinki Metropolitan Area's cities, companies and the Finnish government together with The Finnish Innovation Fund Sitra are establishing a new foundation, which aims at transforming the region to world's forerunner in providing references from smart and clean solution development.
- The non-profit foundation develops concepts aimed at attracting investments and supporting exports. These concepts are divided into five themes:
 - Low-carbon traffic and mobility
 - Energy
 - Built environment
 - Water and waste management
 - Consumer cleantech



✚ VTT Bioruukki Pilot Centre

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Speed to scale-up of bio and circular economy innovations



- A new piloting ecosystem for process industry scale-up and demonstrations.
- A former printing plant transformed to world scale R&D centre.
- 8000 m², room for several pilot units and laboratories.
- Located close to Otaniemi campus.



+ Bioruukki Pilot Centre – Value from integration

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THERMOCHEMICAL CONVERSION PLATFORM

Gasification and
pyrolysis technologies
for biofuels,
biochemicals and
materials

Full operation started
Q3/2015



ENERGY STORAGE PLATFORM

Storage concepts for
solar and wind
energy through mono
carbon gases to
chemicals and
materials

Starts at Bioruukki
2016



BIOMASS PROCESSING PLATFORM

Innovative biomass
fractionation and
processing for new
biobased value
chains

Starts at Bioruukki
2017



GREEN CHEMISTRY PLATFORM

Sustainable process
chemistry; high solid
content processing for
biochemicals and
tailored biobased
hybrid materials

Starts at Bioruukki
2018



Future possibilities in cleantech and bioenergy

- Technology for production of liquid traffic fuels and bio oil
- Energy efficiency in industry and built environment with IoT
- Partnering with Finnish companies in Helsinki region for demonstration of
 - Low-carbon traffic and mobility
 - Energy
 - Built environment
 - Water and waste management
 - Consumer cleantech
- R&D collaboration