



**A simple
solution
to a major
challenge**



2 THE BIG PICTURE – INCREASING POPULATION, ENERGY CONSUMPTION AND WASTE



The world population is increasing to an expected
~9 billion by 2040



Energy consumption and waste generation will increase accordingly



3 WHAT POWERS THE WORLD WILL NOT POWER THE WORLD TOMORROW – PARIS 2015



Source: IEA/gocompare.com

4 EU TARGETS – MAJOR CLIMATE AMBITIONS DRIVE MAJOR INVESTMENTS

By 2050, the EU should cut greenhouse gas emissions to 80% below 1990 levels

Milestones:

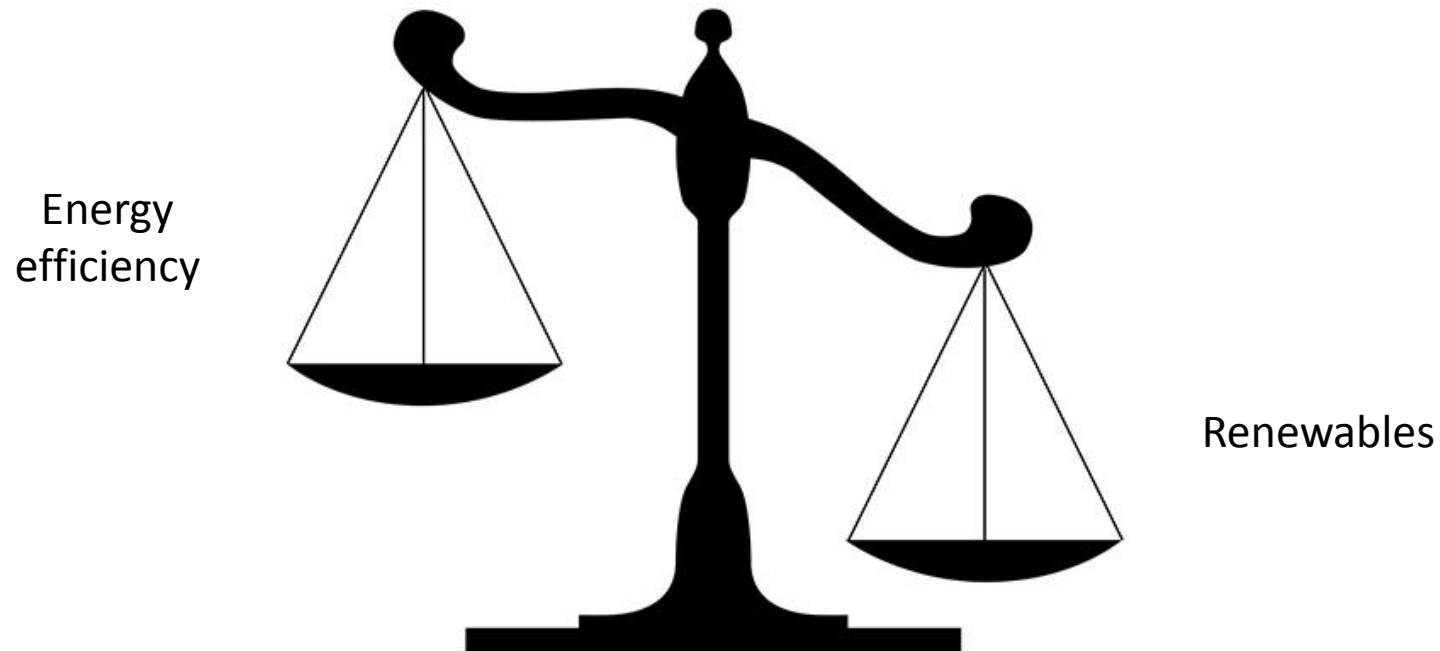
40% emissions cuts by 2030

60% emission cuts by 2040

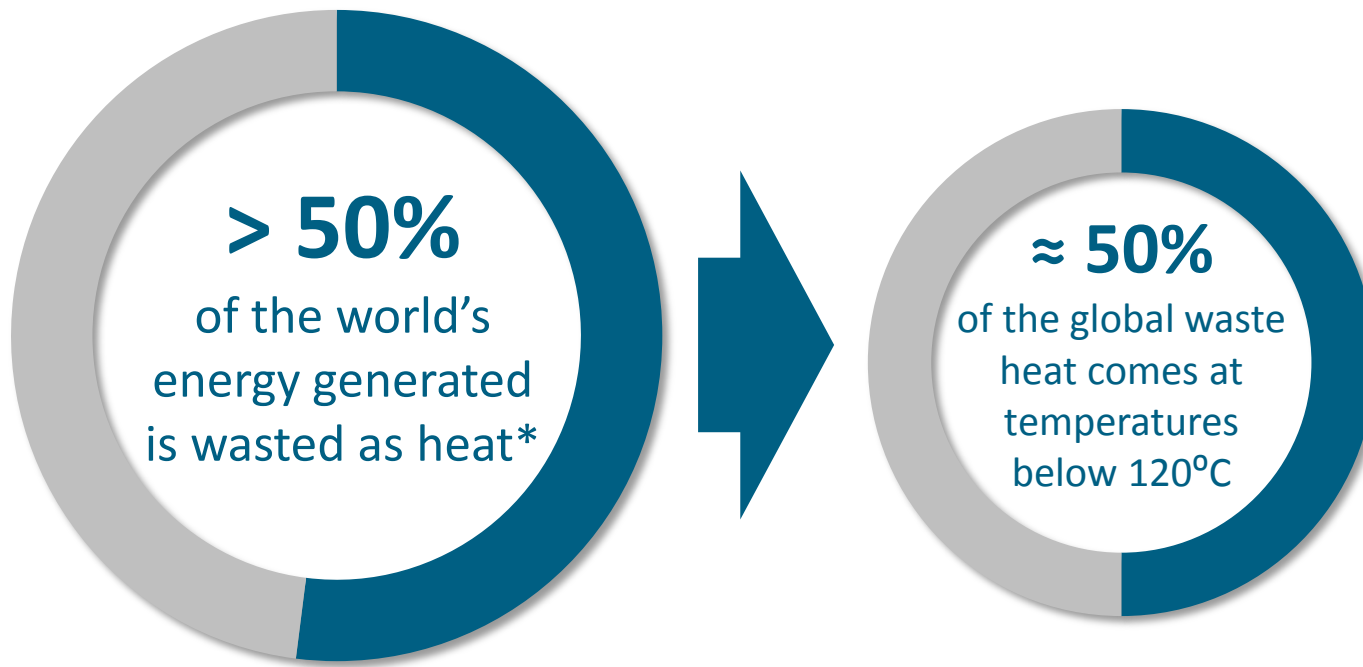
**To make the transition, the EU would need to invest an additional
€270 BILLION
over the next 4 decades**

THE NEXT WAVE OF PUBLIC INCENTIVES AND INDUSTRIAL CLIMATE INVESTMENTS WILL BE IN ENERGY EFFICIENCY - RATHER THAN RENEWABLE ENERGY

Production and reduction are equally weighted in the EU targets, but to date most efforts have gone into the production side



6 WASTE HEAT RECOVERY IS THE HIDDEN JEWEL OF THE RENEWABLE ENERGY SECTOR



**Waste heat at temperatures below 120°C has been difficult to utilise
due to immature technology...until now**

*Lawrence Livermore National Laboratory and the US Department of Energy

7 400 MILLION KRONER AND 9 YEARS ALREADY SPENT



CraftEngine™
Creating valuable electricity from waste heat



HeatBooster
Creating valuable process heat from waste heat

8 | INSTEAD OF ENERGY GOING TO WASTE, WE TURN WASTE INTO ENERGY

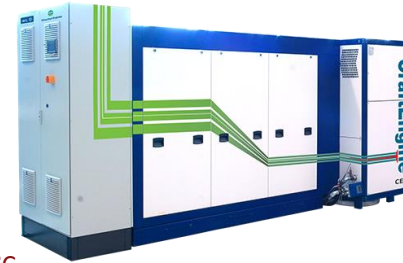


ONE TECHNOLOGY
PLATFORM, TWO
PRODUCT LINES

CraftEngine™

LOW
TEMPERATURE
HEAT IN

Typ.
80 – 200 °C



ELECTRICITY
OUT

Range
40 – 400 kW

WASTE HEAT TO POWER

HeatBooster™

LOW
TEMPERATURE
HEAT IN

Typ.
40 – 100 °C



HIGH
TEMPERATURE
HEAT OUT

Typ.
100 – 160 °C

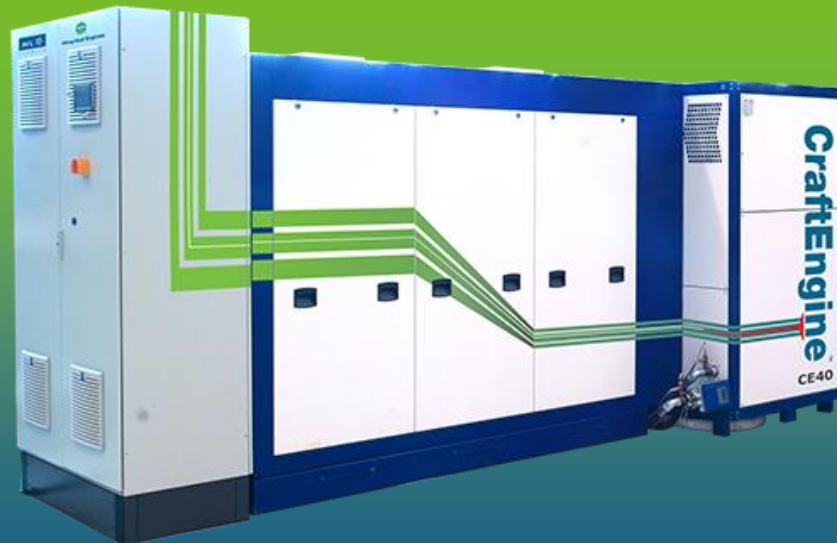
WASTE HEAT TO USEFUL HEAT





CraftEngine™

Organic Rankine Cycle (ORC) heat engine



CRAFTENGINE CASE – SHIPPING



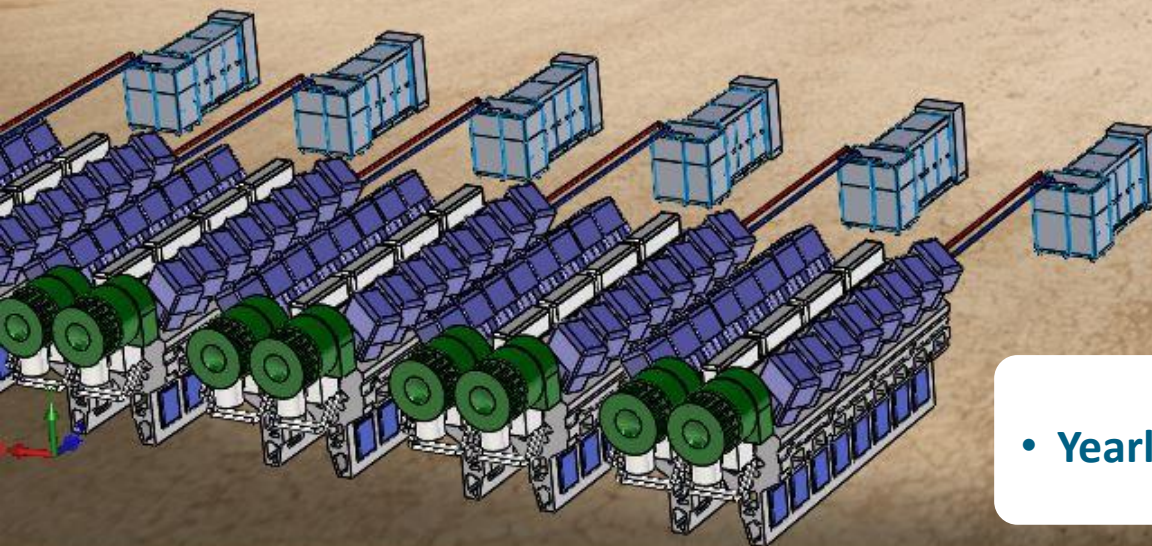
- Example: 1 X 300 kW CraftEngine
- 1 650 MWh electricity produced every year
- CO2 reduction: 800 MT/y



Savings:

€105 000 /y – Payback time 3y

CRAFTENGINE CASE – DIESEL GEN.SET



- Example: 6 x 2,5 MW diesel generator sets
- Fuel savings: 2 950 metric tonnes/year
- CO2 reduction: 7 500 metric tonnes/year

• Yearly Savings : € 1 600 000 → payback time 2y

CRAFTENGINE TURNING WASTE INTO ELECTRICITY



- 5 tons of garbage per day = 40 kW of electricity
- Distributed waste handling
- Distributed electricity production

HeatBooster

Industrial Heat Pump System



14 POSSIBLE APPLICATIONS



HeatBooster increases energy efficiency

- Costs and emissions can be drastically reduced
- Payback periods of 1 to 3 years are possible



HeatBooster reaches the highest temperatures (> 150 °C)

- Commercial industrial heat pumps generally reach < 90 °C
- The market potential is 4-5 times bigger in the 100-150 °C range



15 WHERE THERE ARE CHIMNEYS, THERE IS HEAT TO BE RECOVERED



Approx. 400 TWh industrial waste heat in Europe alone!

HEATBOOSTER CASE – DRYING OF CAR PAINT

Example:

- 1 plant 150.000 cars/year
- 20 x 1 MW HeatBoosters

GHG savings:

11,952



Passenger
vehicles
driven for one
year

US EPA

Energy savings:

6,027



homes' energy
use for one
year

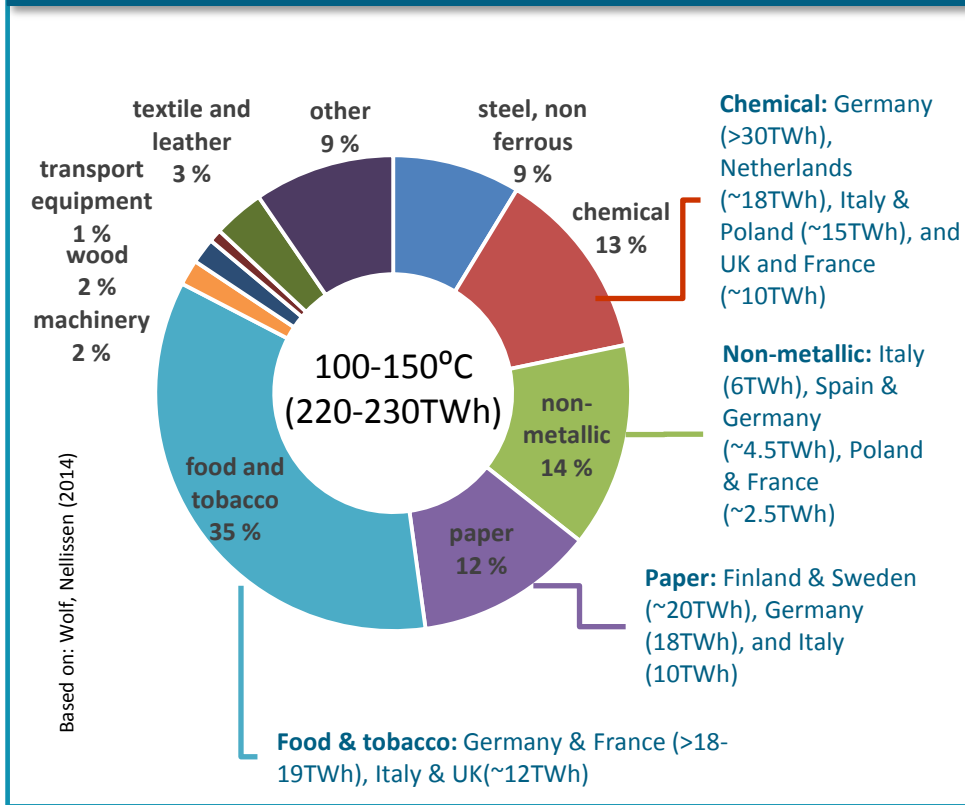
US EPA



Industry Targets: Toyota's goal is to cut 50% of the Co2 emission by 2025 and zero emission by 2050

INDUSTRY REQUIREMENTS FOR OUTPUT TEMPERATURES IN THE RANGE OF 100-150°C -> VAST OPPORTUNITIES

HEAT DEMAND OF 220-230 TWh IN THE 100-150 °C RANGE IN SELECTED EUROPEAN INDUSTRIES (2012)



Sources: Delta Energy & Environment Ltd. and Électricité de France

Technical market potential in EU & USA alone:
~ 500 TWh, which translates to 100.000 x 1MW HeatBoosters

“Practically reachable” potential: 15% of above, e.g. 15.000 units

CO2 savings: 32 million tons
VHE turnover: €4 billion

VIKING HEAT ENGINES IS ATTRACTING WIDE INTEREST FROM LARGE INTERNATIONAL INDUSTRIAL PLAYERS – BUT **MORE PARTNERS ARE WELCOME!**

A FEW OF THE COMPANIES THAT VIKING HEAT ENGINES IS IN COMMERCIAL DISCUSSIONS WITH



Viking Heat Engines



**Our Vision is to accelerate the world's energy
transition towards a sustainable future.**

www.vikingheatengines.com