Torrefiering av biomassa – teknik och utveckling

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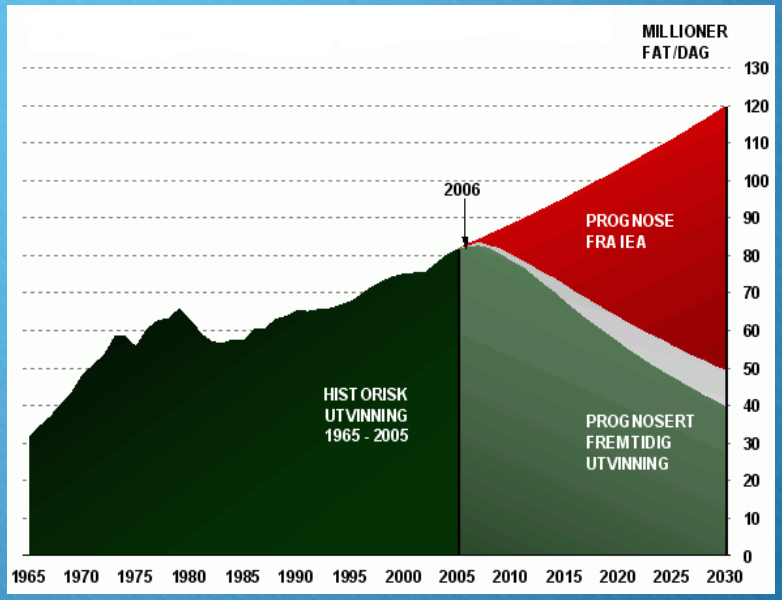
PANNDAGARNA 2012

Why?

Mankind´s greatest challenge!

Climate

Oil gap

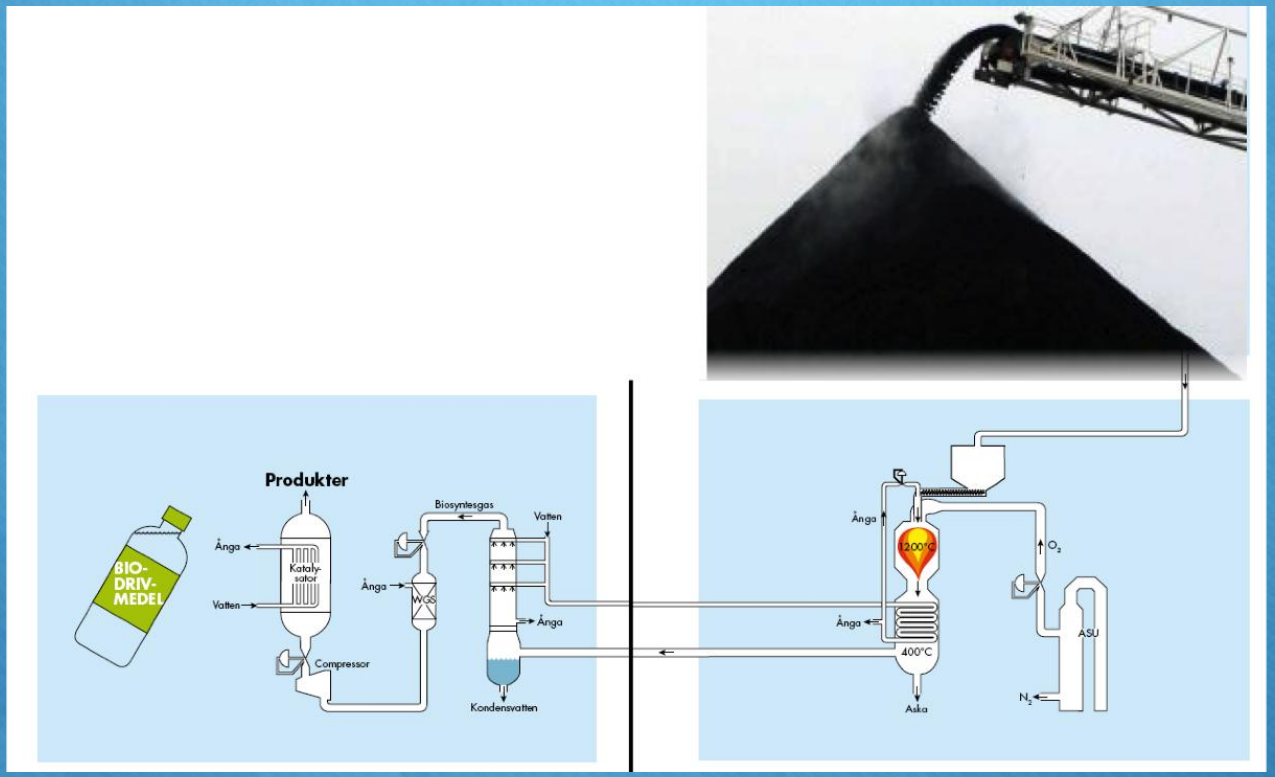


Biomass one of the wedges/solutions

- but in a gigantic scale !!!

Chinese have understood,
huge coal resources

Large scale CTL Systems Now!



A 500 MW Siemens Gasifier to China

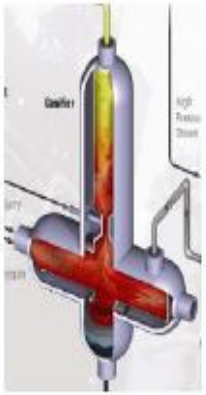
5 installed in operation, 8 under construction, 24 ordered

E T P C

Entrained Flow Gasifiers

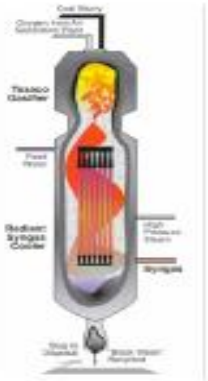
+ Industrially well proven (coal)
+ High Efficiency
+ High gas quality
+ Cost-efficient

! Large scale (costly)
! Fuel requirements higher
! High temperature
! Container material

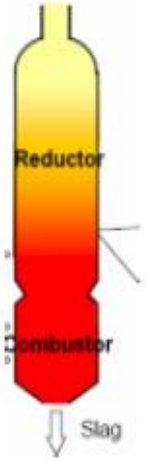


ConocoPhillips

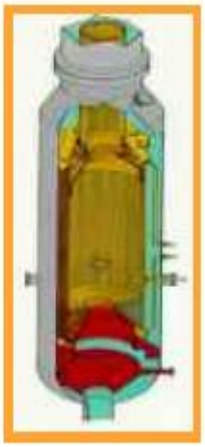
E-Gas (6)



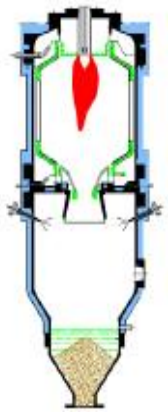
GE (Texaco) (76)



MHI

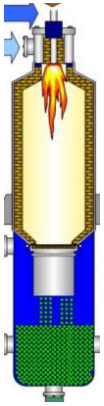


Shell (52)

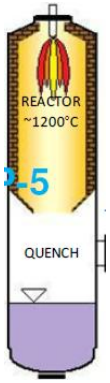


Siemens

Uhde



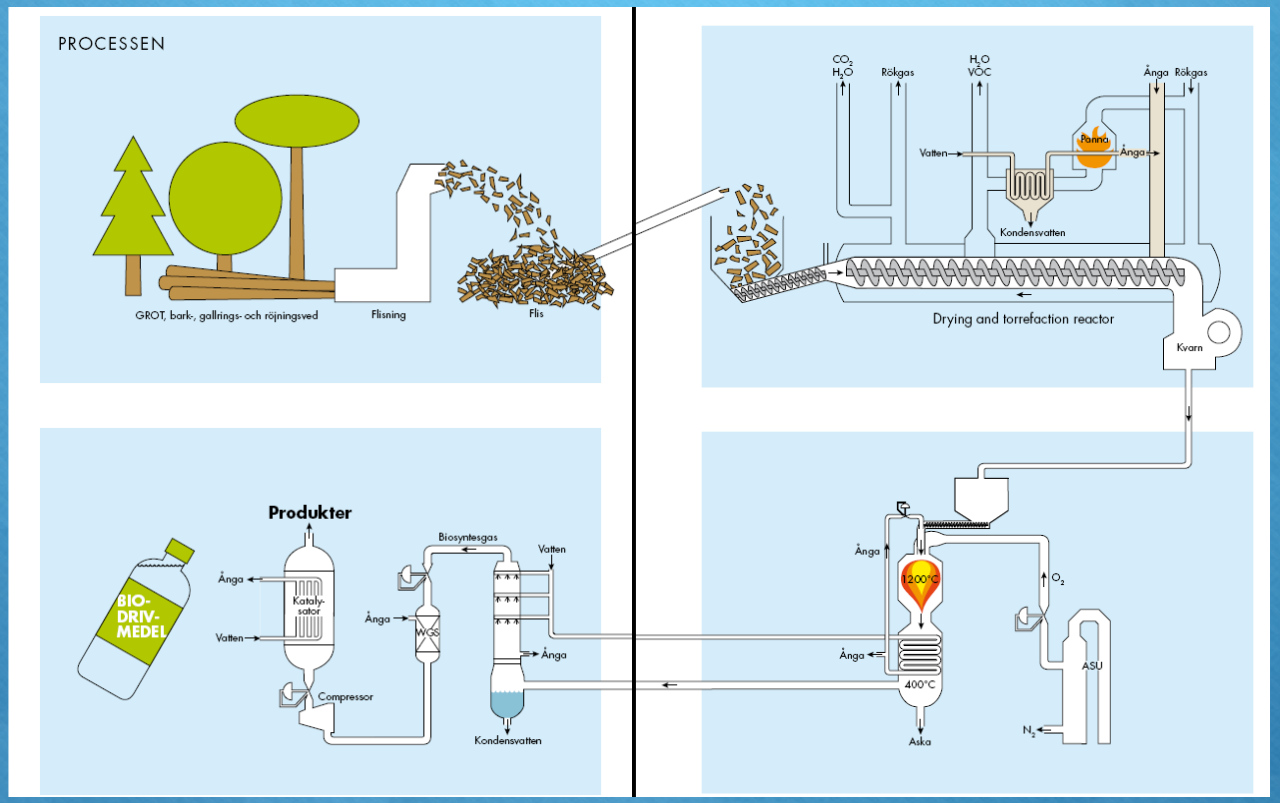
Chemrec



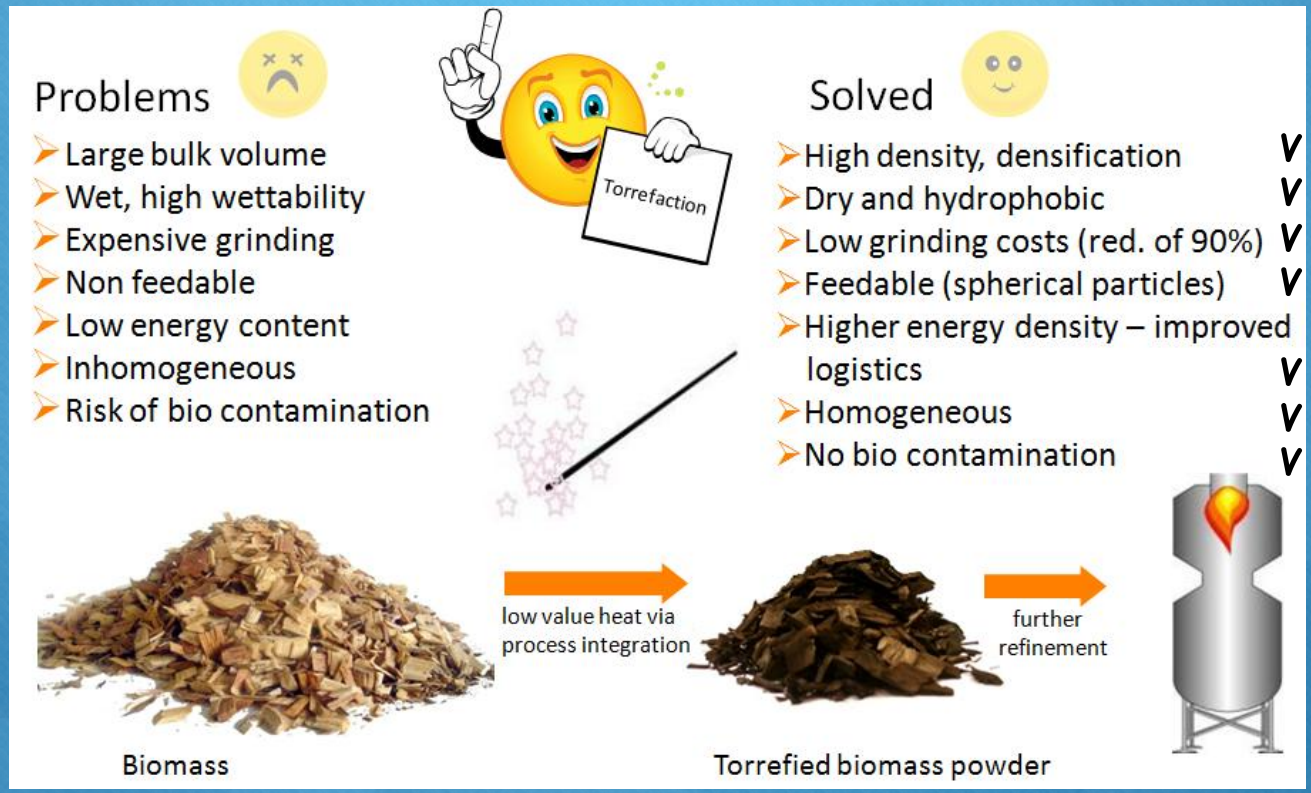
PEBG, ETC

MEVA

Simply Green Coal!!!



Torrefaction!

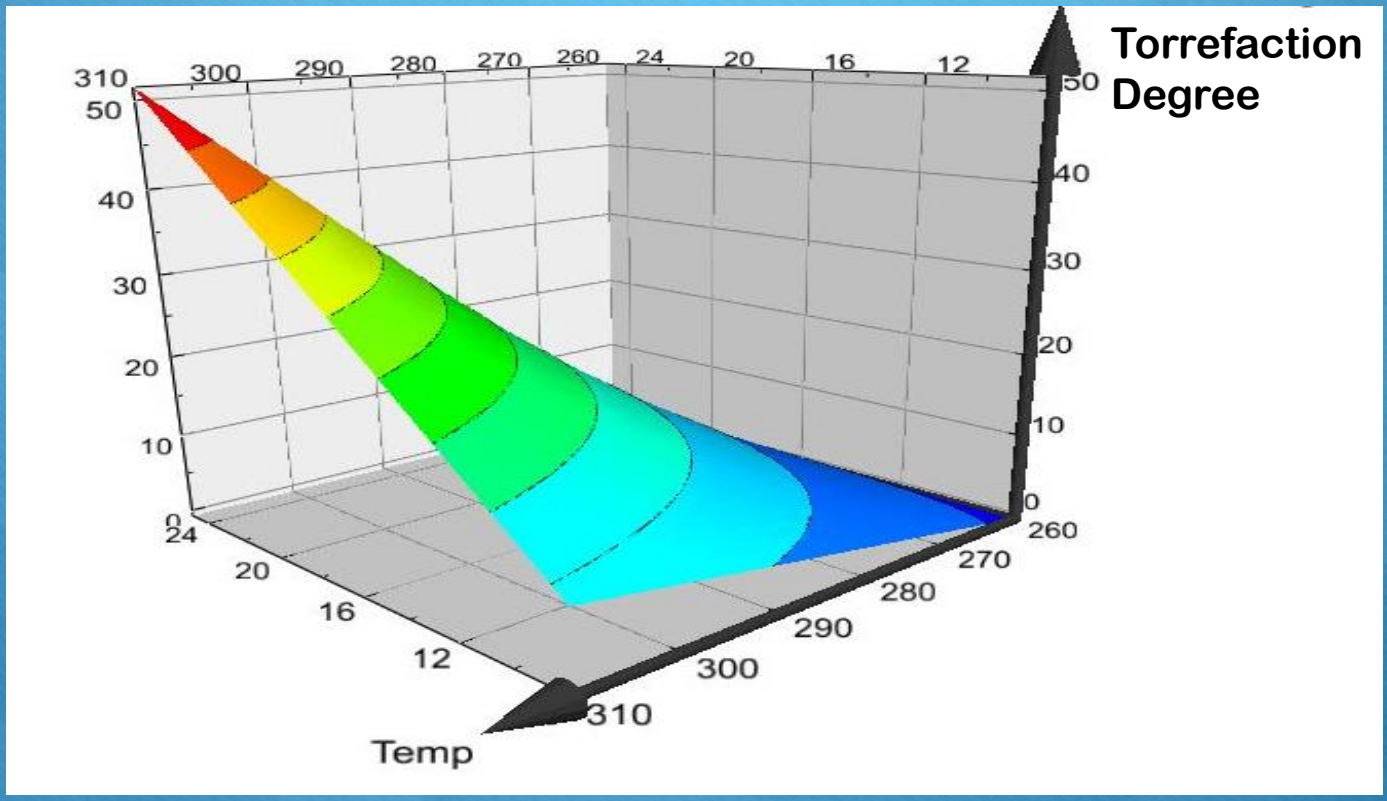


Pilot (20 kg/h) since 2009

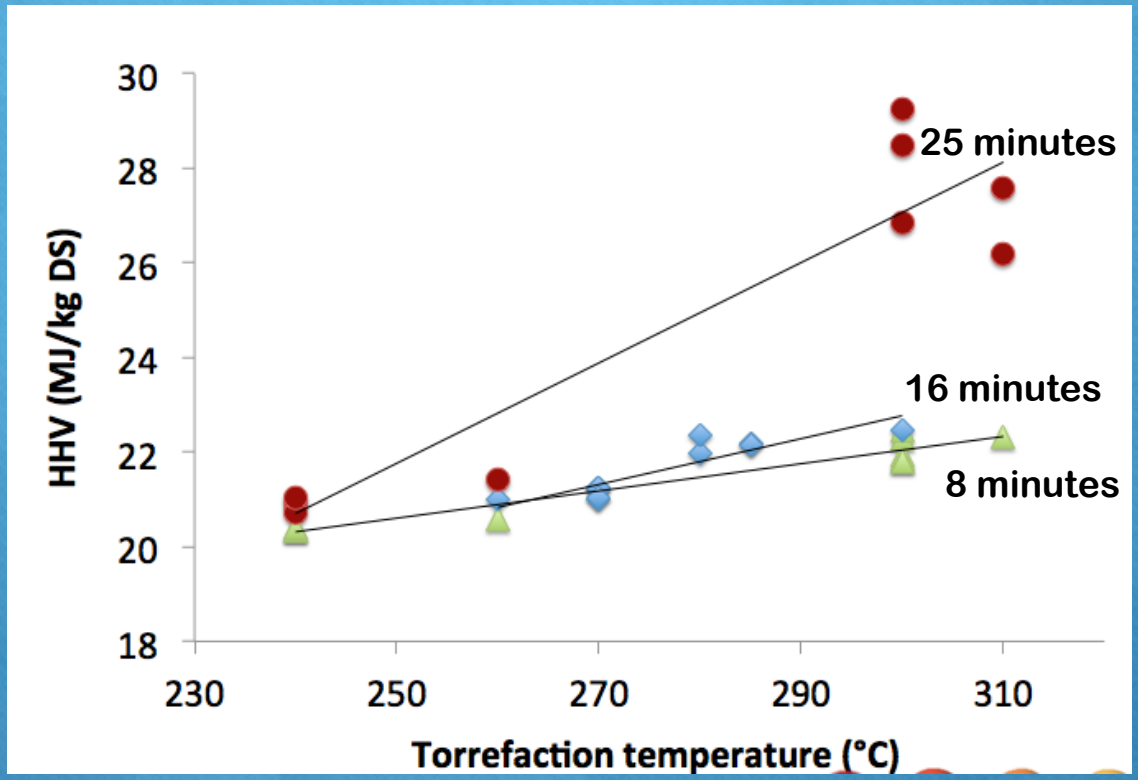
Totally 3 years
Spruce
Eucalyptus
Forest residues
Reed Canary grass

E T P C

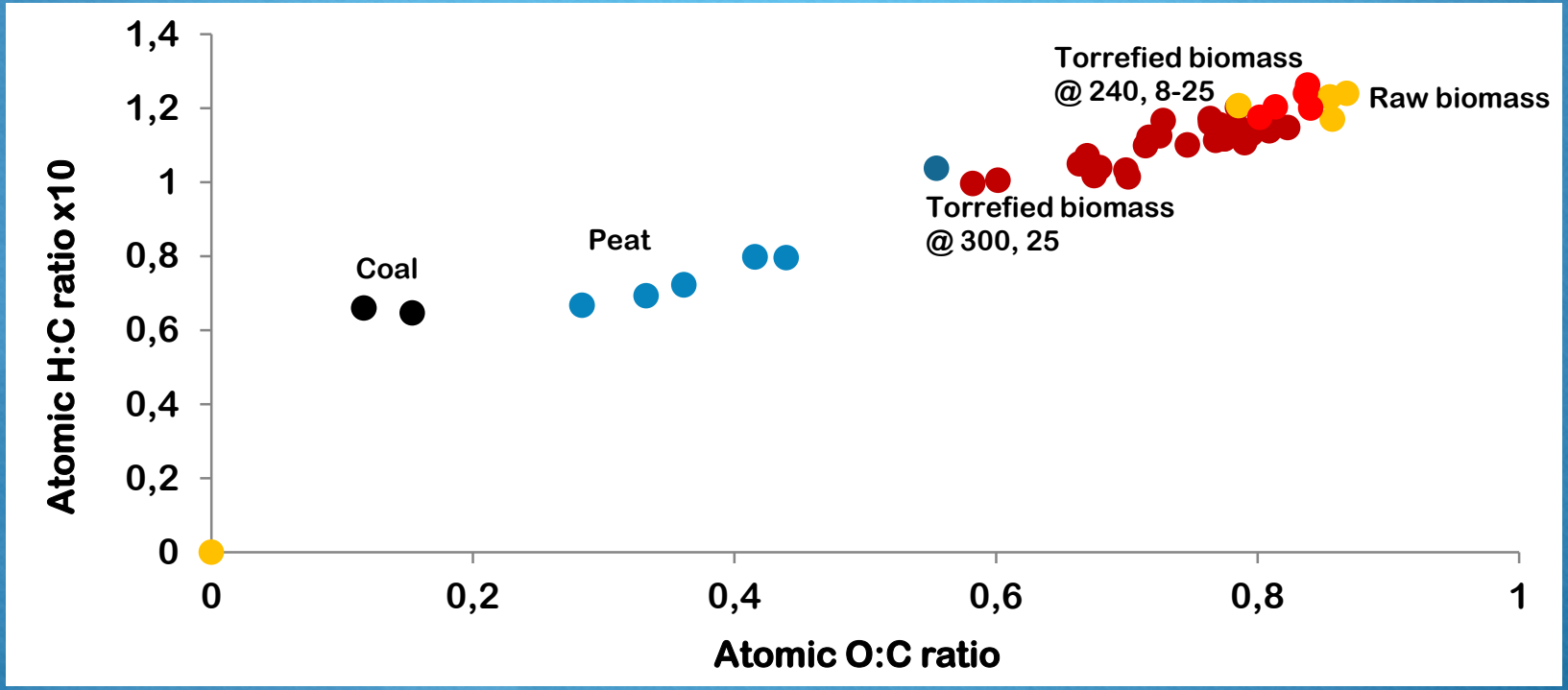
A few illustrations of results



A few illustrations of results



A few illustrations of results



Torrefied and densified

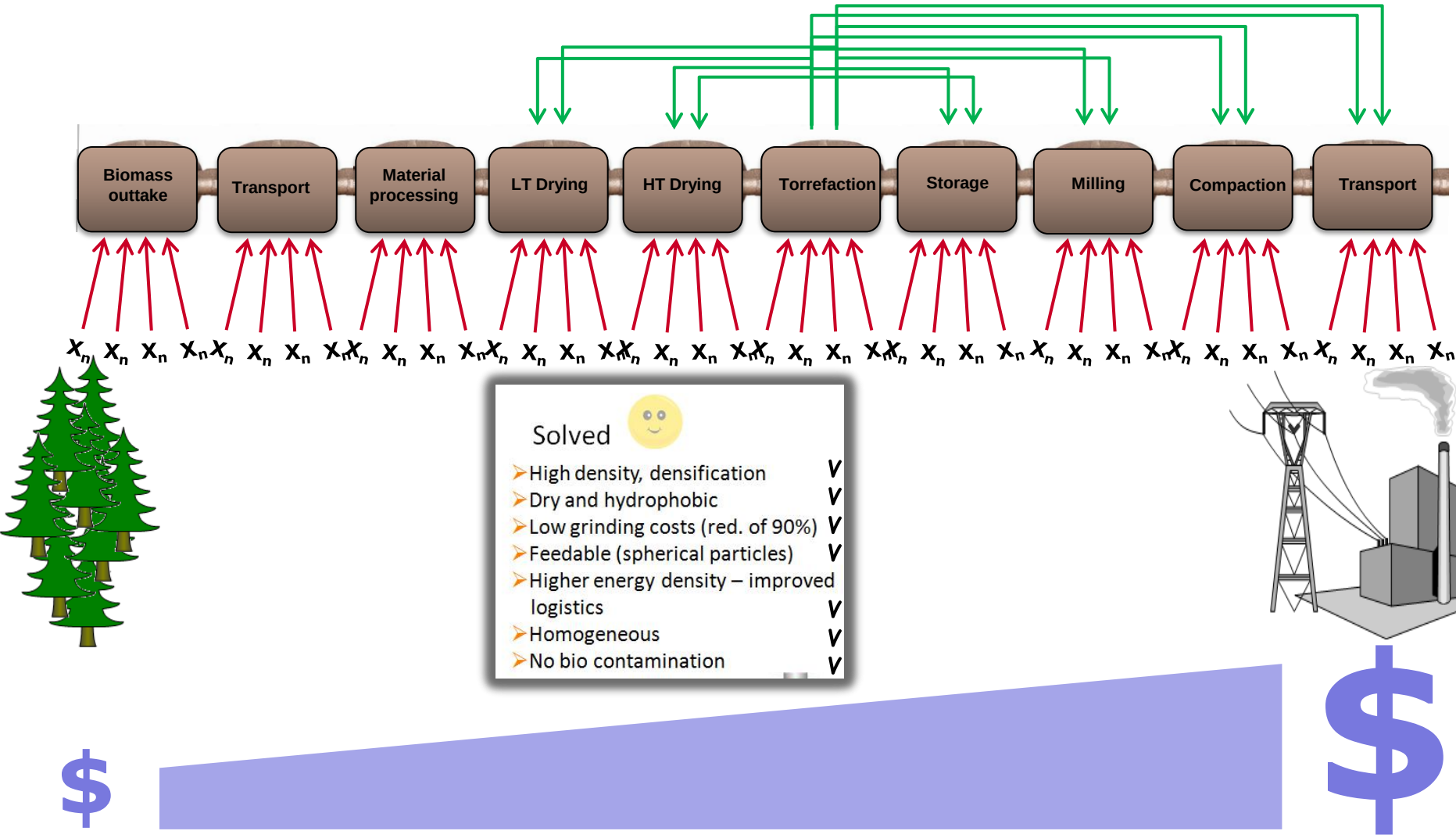
- 10 tests, all successful…..

Consumed Energy of Production

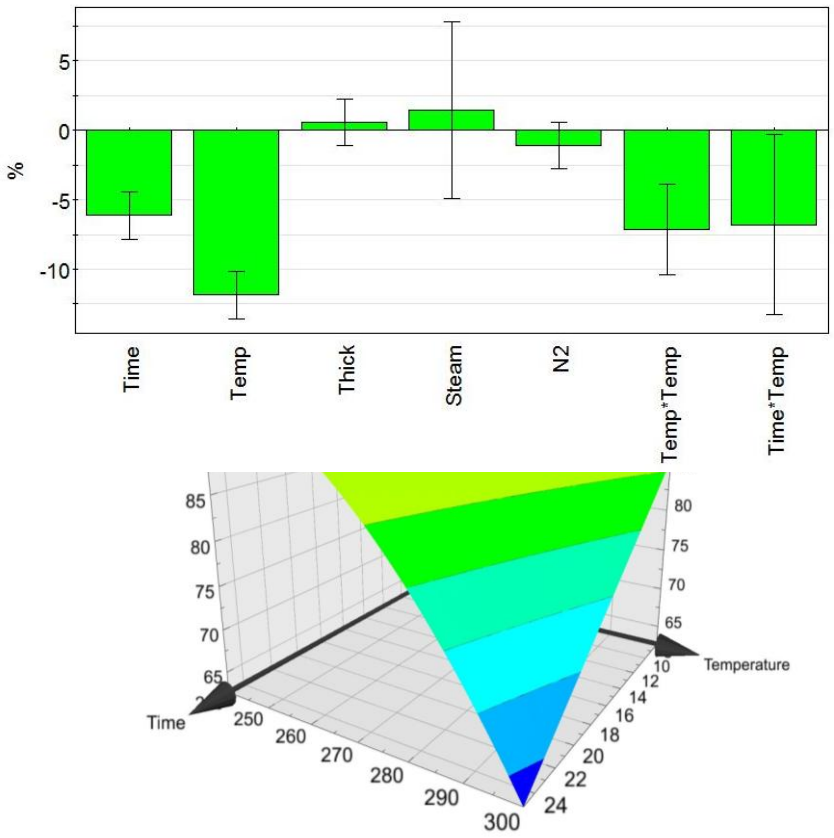
	Raw Spruce	Spruce Severe TF	Eucalyptus 300/16.5	
Drying from 50% to				
Drying (0.7kWh/kg H_2O)				**kWh_{heat}/ton_{DS}**
Heating and torrefaction				**kWh_{heat}/ton_{DS}**
Milling to powder 0.25mm				*kWh_e/ton_{DS}*
Milling to powder 1mm				**kWh_e/ton_{DS}**
Pelleting (mass basis)				**kWh_e/ton_{DS}**
Pelleting (energy basis)				*kWh_e/MWh*
Total heat approximately				**kWh_{heat}/ton_{DS}**
Total power approximately				**kWh_e/ton_{DS}**
Total power approximately				*kWh_e/MWh*
Total approximately				**kWh_{energy}/ton_{DS}**

Challenges – Cost retalted

Analyze and optimize the whole supply chain!

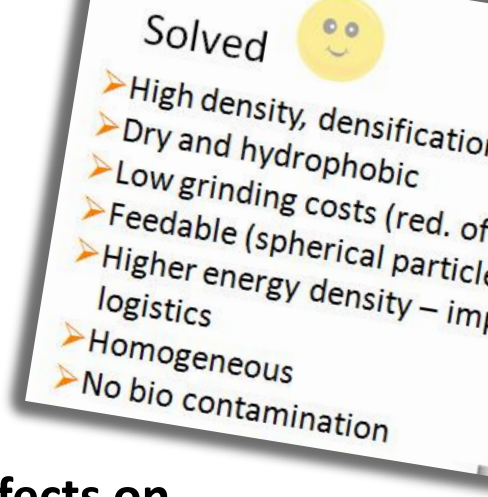


Preliminary Results
Effects on Energy Yield



Total costs for a large scale plant

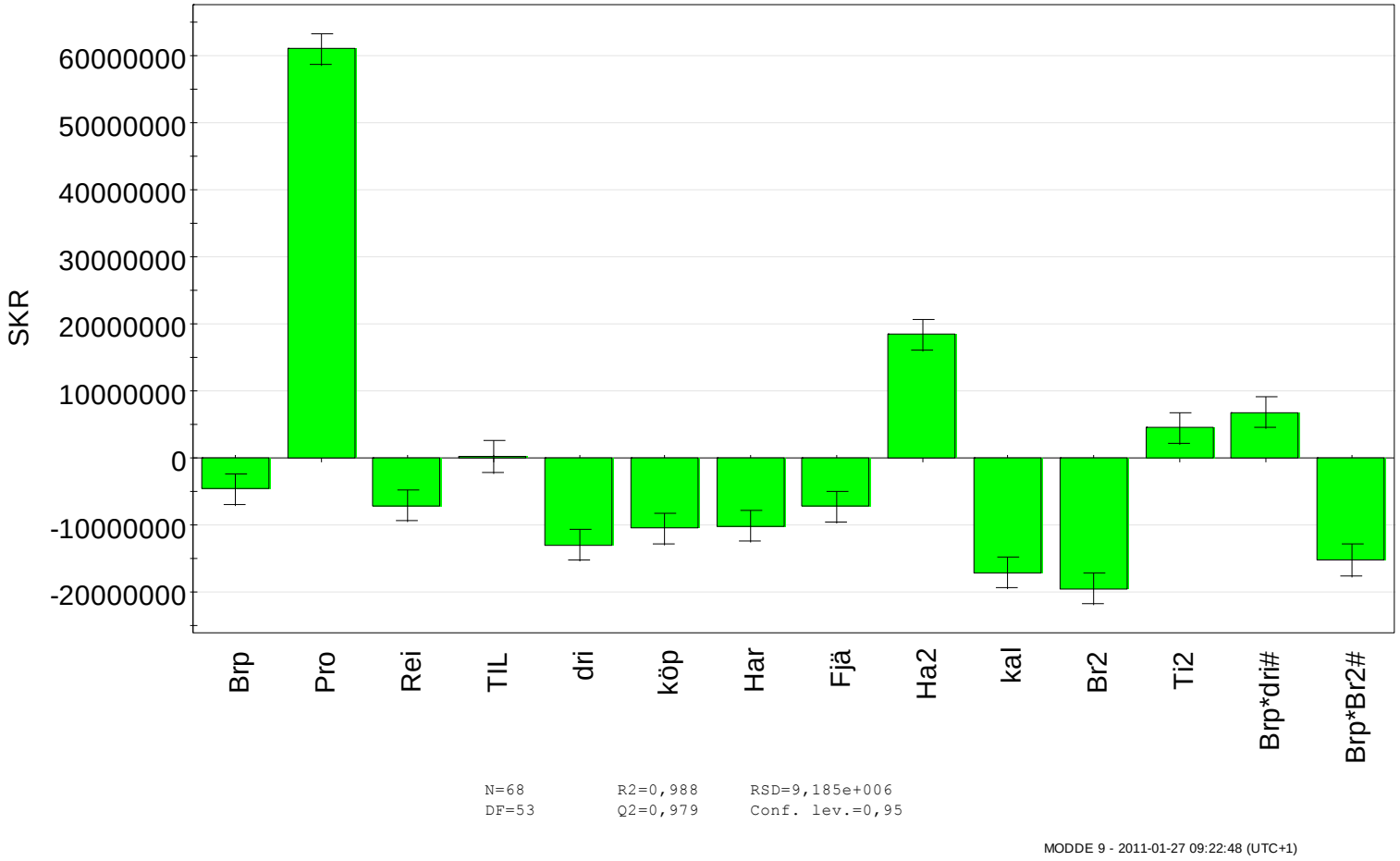
- Raw Material Cost
- Product Prize
- Investment Cost
- Reinvestment Cost
- Accessability
- Operating Staff
- Torrefaction Degree
- Service Costs
- Low Temperature Heat Costs
- High Temperature Heat Costs
- Capital Costs



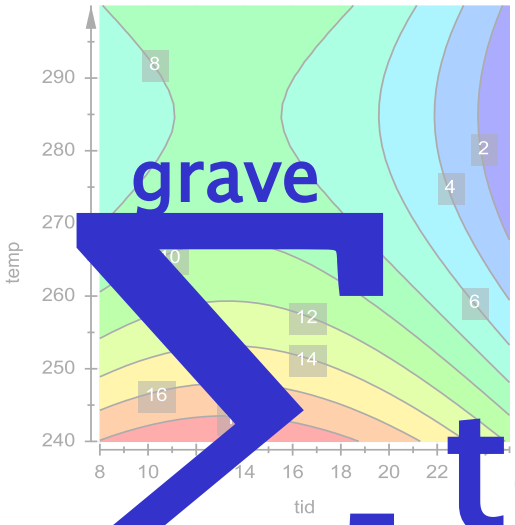
Effects on

- Net Present Value
- Payback Year
- Profitability

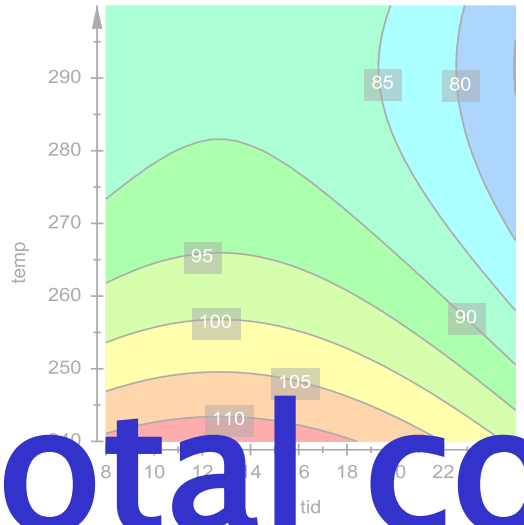
Net present value



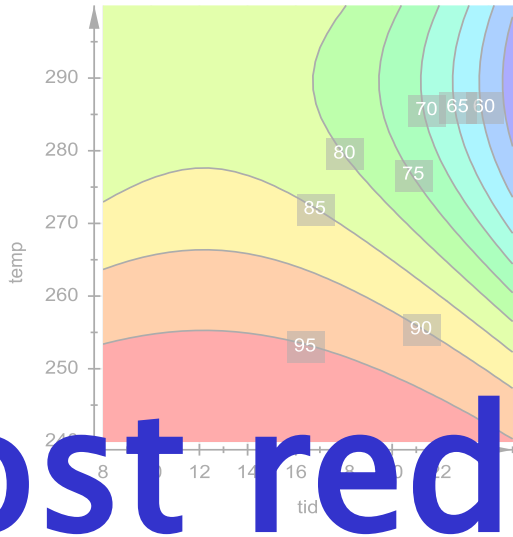
Milling cost



Energy yield



Mass yield

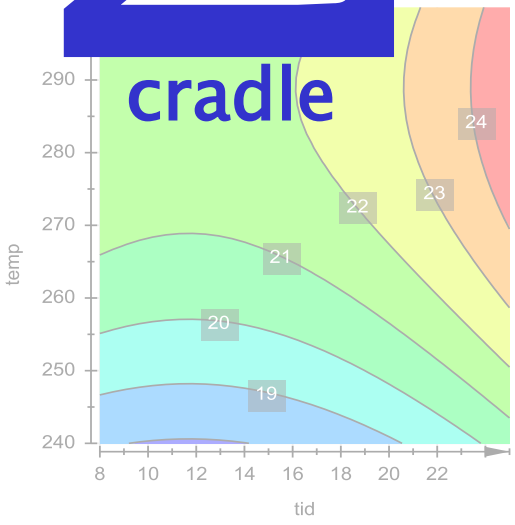


grave

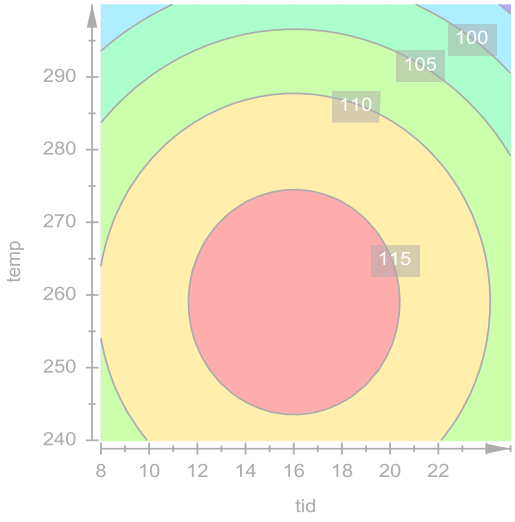
$\sum$ total cost red

cradle

HHV

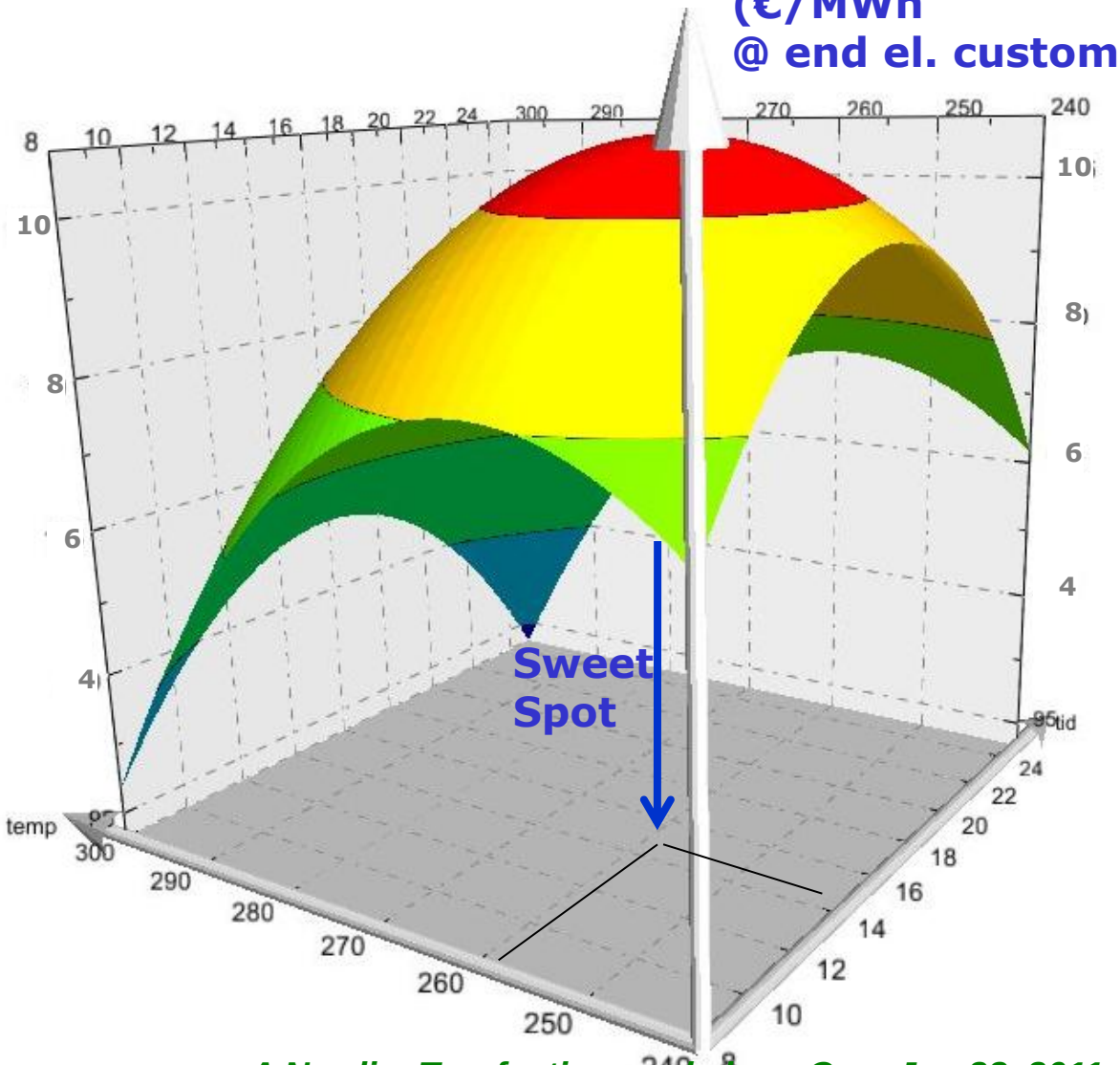


Hydrofob 5min medel



Final Composite Response with economic weights - always end customer specific

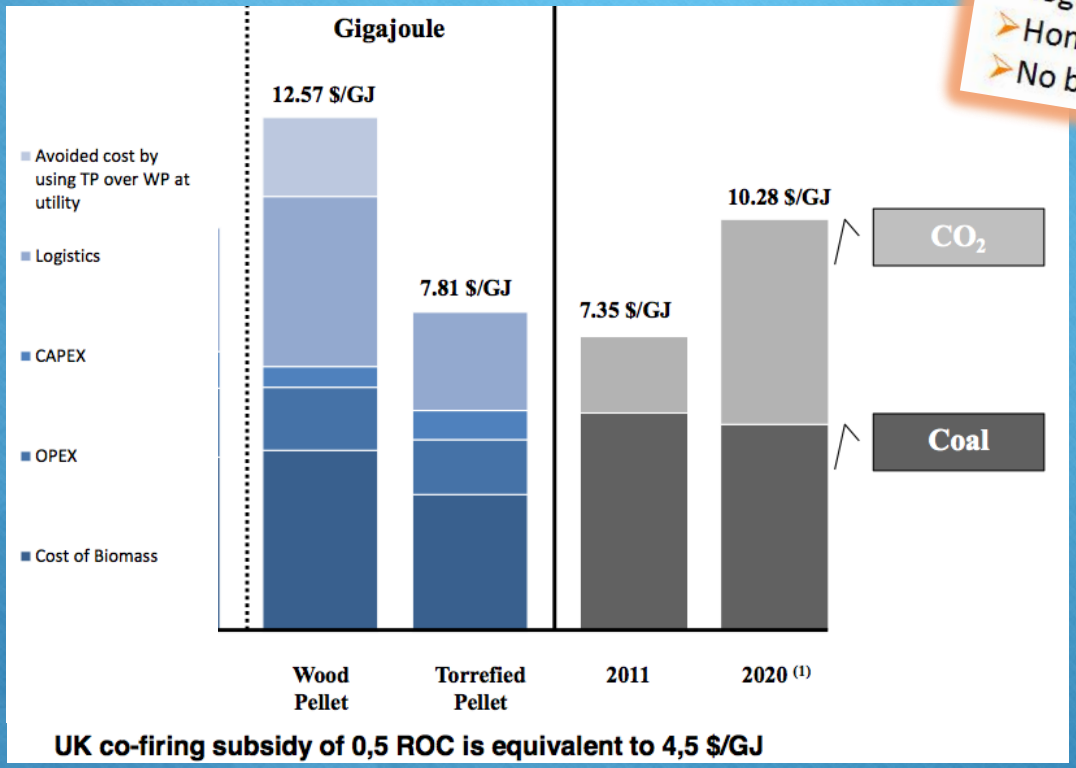
Total savings (€/MWh @ end el. customer)



Some words (from Vattenfall, RWE) on economy

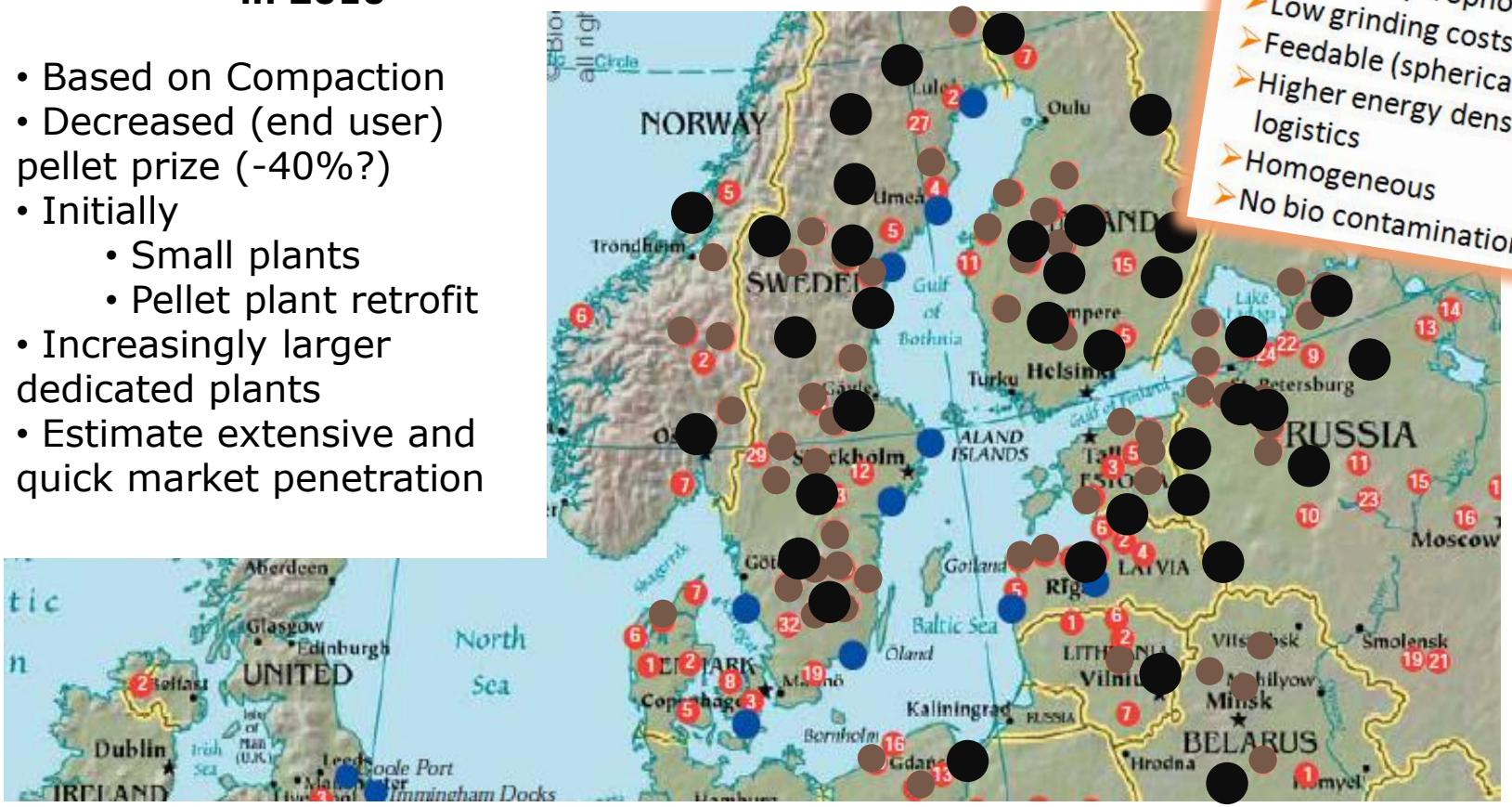
Solved

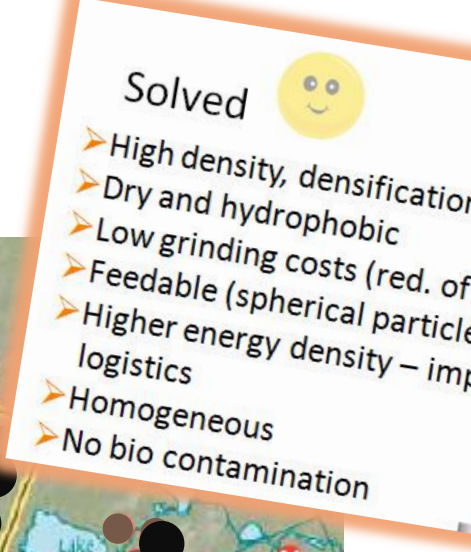
- High density, densification ✓
- Dry and hydrophobic ✓
- Low grinding costs (red. of 90%) ✓
- Feedable (spherical particles) ✓
- Higher energy density – improved logistics ✓
- Homogeneous ✓
- No bio contamination ✓



Pellet Production Plants: 0 in 1990; in 2010

- Based on Compaction
- Decreased (end user) pellet prize (-40%?)
- Initially
  - Small plants
  - Pellet plant retrofit
- Increasingly larger dedicated plants
- Estimate extensive and quick market penetration





5 15 30 50 80 >10

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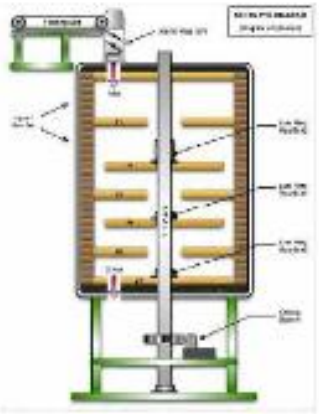
2012 2014 2016 2018 2020

Industrial Gasification

Development status (international)

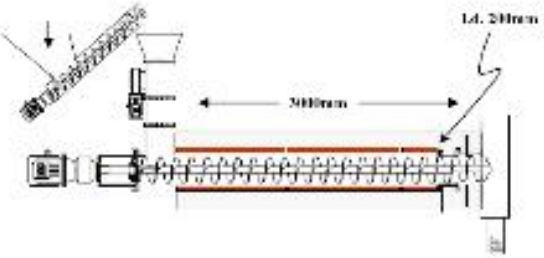
- *> 50 initiatives* *TorreFacts Online*
- *> 10 initiatives with industrial production 2010-2012*
  - *Roterande trummor (Andritz, Torkapparater, BioEndev/Metso…)*
  - *Moving bed (ECN…)*
  - *Fluid Bed (Stramproy …)*
  - *Fast dryers (Topell, Wyssmont…)*
- *All different technologies have their inherent pros and cons*
  - *Proven technologies?, Heat transfer?, Process control……*
- *Slower – faster than expected?*



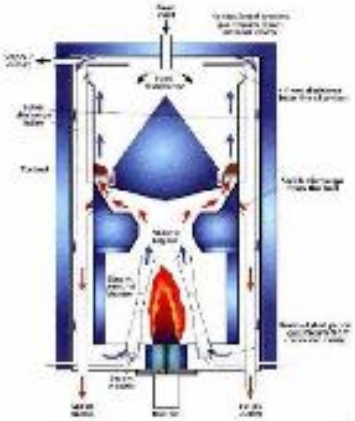
Multiple hearth furnace

Rotary drum reactor

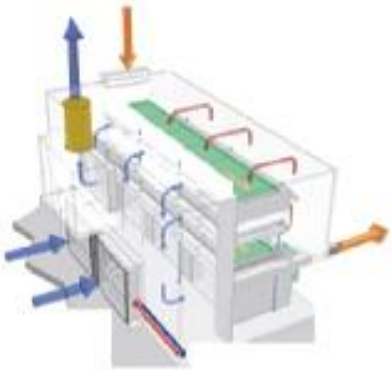
Moving bed reactor



Screw conveyor reactor



Torbed reactor



Oscillating belt reactor

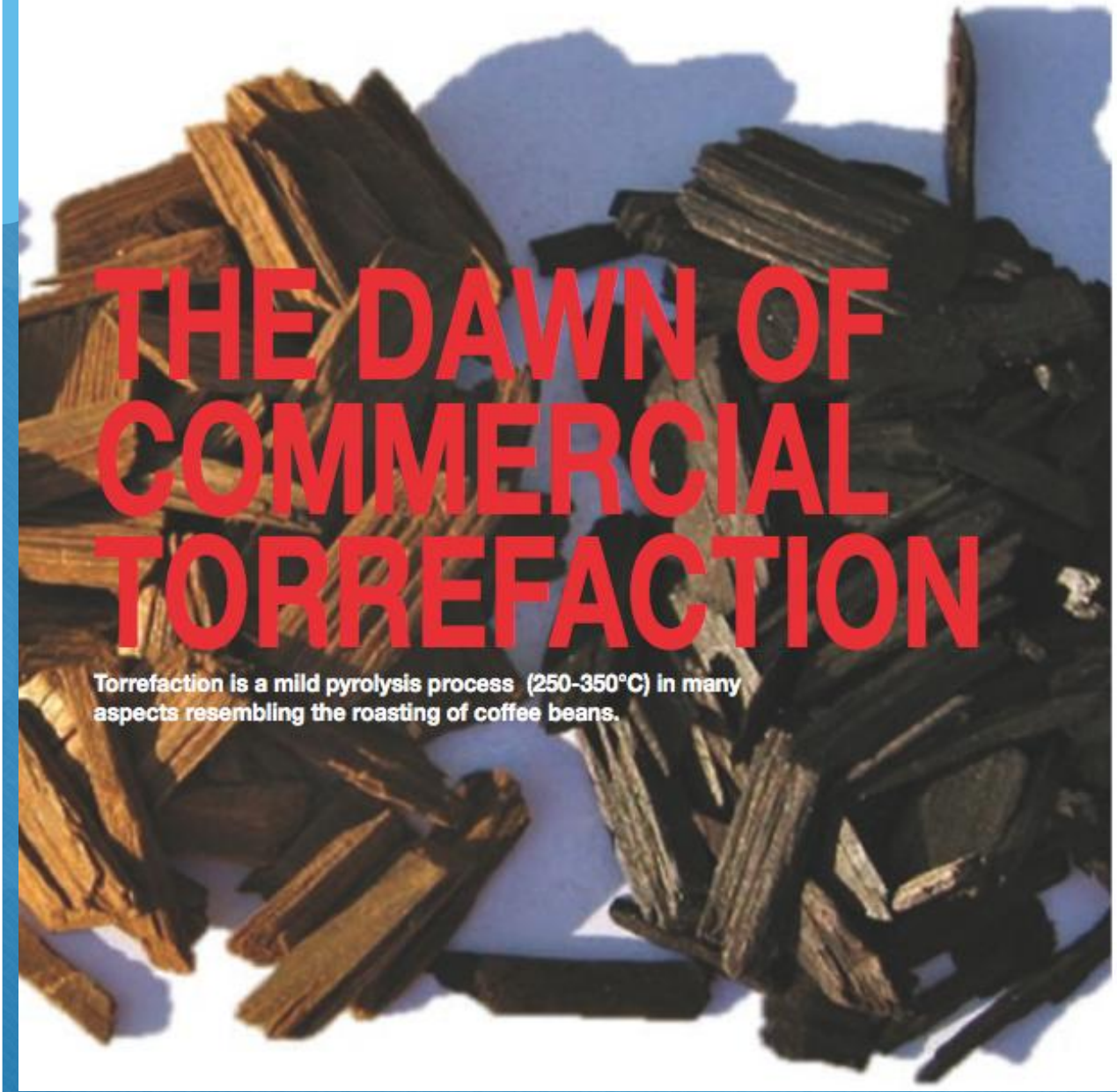
TurboDryer

Microwave reactor

E T P C

Development status – commercial plants

- Stramproy 2010-
- Topell 2011- full capacity 2012-
- Black Pellets – Norge Vattenfall (
- Torkapparater – Gotland Dec 2011- (4x25 ton)
- North America – Extensive interests (Georgia)
- BioEndev – Övik 2 t/h 2012-



THE DAWN OF COMMERCIAL TORREFACTION

Torrefaction is a mild pyrolysis process (250-350°C) in many aspects resembling the roasting of coffee beans.

Torrefaction is a mild pyrolysis process (250-350°C) in many aspects resembling the roasting of coffee beans. Done right, the biomass is refined into a higher value "instant coffee-like" product, also with a "refreshing" aroma. This smokey biomass scent might well soon be as familiar to all of us as the well-known "smell of money" steaming from the Nordic pulp mills.

Anders Nordin | ???????????

During the last ten years a tremendous R&D effort from a multitude of committed torrefiers has paved the way for an army of different emerging torrefaction technologies. Scientists and engineers have gathered extensive experimental data on how varying biomass raw materials all benefit from torrefaction. The process generally increases bulk energy density; calorific value; water resistance; and the product can easily and efficiently be densified into pellets or briquettes and/or ground into powder. Biological activity is terminated, reducing risk of degradation, spontaneous combustion as well as spreading of invasive and non-indigenous species. The final powder fuel may also more resemble coal powder in terms of feedability and process behavior.

These ten significant and important changes in characteristics all contribute to improved economics of the whole supply chains, as shown in a number of industrial system and fuel supply studies.
Today, four industrial-scale torrefaction plants are up and running. Costs are still to be reduced, technology improved and availability increased, but all these efforts are paving the way for commercial torrefaction.
Although "the future looks dark", a brighter day seems to be arriving for the biomass industry.

Competing against the low-cost fossil fuels need maximum efforts on all economic savings in the whole processes, systems and supply chains, i.e. a multitude of measures of different scientific and engineering nature. In the best of all worlds, the systems should also be based on well-proven and robust technologies, with minimal operational and investment costs, suitable also for up-scaling to hundreds of tons capacity. Thus, there are still some efforts in getting there.

We all feed on hope and excitement, but we also need to be humble in our expectations and plans. Development normally takes time - generally 10-20 years for a new product or process to reach commercial success.

Thank You!

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E T P C