Alternatives to re-refining used oil in a volatile price environment and a low-carbon economy

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F+L Week 2016

8-11 March 2016

Regent Hotel, Singapore

Agenda

- Lubricant and used oil facts
- A brief history of treatment of used oil
- Main type of treatment processes
- Economics (example with two processes)
  - Impact of plant size on costs
  - Transport cost and limited feedstock
  - Size increase versus transport costs
  - Impact of high volatility on cash flow, Payback at various sizes
- Questions

Lubricant and used oil facts

- The average lubricant used in the world is 5.5 kg per person per year but it varies greatly by region.
- Additives represent 10 to 15% of the composition of oil, the rest being base oils.
- Lubricants, once used, have to be disposed of in an environmentally friendly way. (EPA: Just one gallon of used oil can pollute 1,000,000 gallons of fresh water).
- Out of one ton of new motor oil about 73% will become used oil. The rest will be consumed during usage.
- Between 2000 and 2014 the global Lubricant market(ex: marine oils 4.5MMT) has gone from 36.4 million metric tons to 35.4 **a decrease of 2.7%** while in the same period energy from petroleum, gas and coal **has gone up by 38%, 17% and 40% respectively**.
- From Wikipedia number of vehicle registration 2012 =1,114 million versus 2000= 751 million a **48% increase.**

Lubricant and used oil facts

- Processing of used/waste oils uses same basic principles as refineries distillation, cracking hydrotreating and other finishing processes.
- Changing specifications standards for lubricant, technology, transport costs, environmental laws and price of crude and products all greatly impact the choices to be made in used/waste oils treatment.
- In environment the key is **reduce**, **reuse** and recycle.
- In environment economics matter.

Used/waste oil history overview

- From the 1950s to 1970s there were 300 “re-refineries” in the US which “disappeared” in the next decade mainly because changes in oil specifications made “filtered” used oil unsalable.
- 1995 approximately 400 re-refineries were in operation in 23 countries. Mostly acid-clay.
- 2003 - fewer than 30 in 14 countries because of regulations against acid-clay and low prices for oil products.
- 2008 – approximately 62 in operation or nearing completion in 21 countries helped by subsidies, regulations and high margins for base oils.

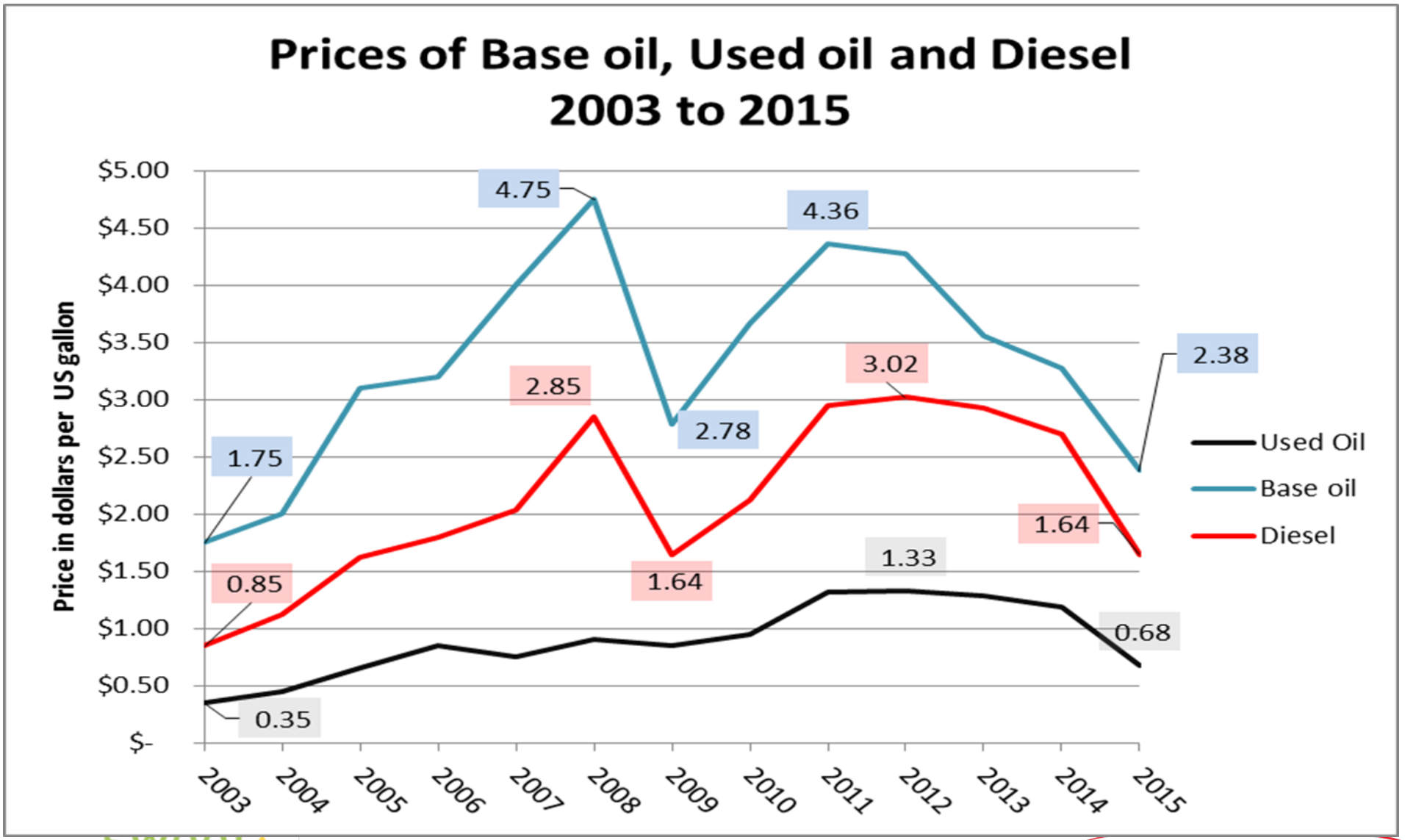
Used/waste oil history overview

Success of distillation-hydrotreating 2004+

- Help from governments to develop technology and banning acid-clay in many countries
- Base oils margins explode
  - Consolidation of base oil producers
  - Little base oil refining capacity added since 2000, thus tight supplies especially in 2008
  - Great increase in crude oil prices
  - Higher standards for base oil = switch from group 1 to group 2
- Strong increase in the quantities of used oils collected
  - Government regulations
  - Higher prices for used oil
- Group 2 production less costly than group 1
  - This is also helped by the collapse of natural gas prices due to fracking especially in the USA.
  - Technology of hydrotreating allows production of group 2 and 3 (better quality) at a lower costs than to make group 1 by extraction (30%)

High volatility of oil prices

US prices of base oil, used oil and diesel over 12 years



Used/waste oil history overview
The future?? 2015+

- Base oils margins collapse
  - Great amount base oil refining capacity added since 2012 nearly all in group 2 and 3. Presently oversupply?
  - Crude oil prices cut by more than half (Fracking)
  - Higher standards for base oil
  - Premium Pricing of Group 2 over Group 1 has disappeared
- Quantities of used oils stabilize in many countries
  - Synthetic oils last longer (fewer oil changes) and motors are smaller
  - Lower prices for used oil
- "Re-refinery" costs compared to other base oil producers
  - Average re-refinery is 6 times smaller
  - Lower cost for used oil but higher cost for transport
  - Quality of feedstock has impact on finished product and/or costs
- **New Technologies**

Process types
Used Lubricating Oil Processes

There are over 30 technologies that can be put in seven major categories:
3 that make mainly fuels and 4 that make base oil.

- **Vacuum distillation**
  - -Produces vacuum gas oil that need to be sold to a refinery or treated
  - -Relatively low capital and operating costs
  - -Disposal of oily sludge
- **Burning**
  - -Low costs and flexible
  - -Low margins in competition with coal and gas and garbage
  - -If burned improperly, used oil can produce dangerous metal oxides and furans or dioxins
- **Thermal Cracking**
  - -Produces fuel and, until recently, lower margin products
  - -Low capital and operating costs
  - -Relatively simple = do not need sophisticated operators
  - -Lower by products to dispose of (no harmful by-products in most cases) for latest technologies

Process type
Make Lubricating Oil Base stocks

- **Acid Clay**
  -Low capital and operating costs but low Yield.
  -Need to dispose of spent clay and acid (environment problem)
  -Banned in many countries.
- **Vacuum Distillation with Hydro finishing (2 biggest)**
  -Produces base oils (group 2 with experience)
  -High capital and operating costs = need for larger plants= larger collection area and transport costs
  -Disposal of spent catalysts
  -Operates at high temperatures and vacuum – Skilled labour required
  10 to 15% product from additives (VTAE) needs to be dispose of or sold to add to asphalt.
- **Hydro treating – UOP**
  -Produces base oils (group 3 with experience)
  -Highest capital and operating costs = need for larger plants = larger collection area and transport costs
  -Disposal of spent catalysts -Operates at high temperatures and vacuum – Skilled labour required
  10 to 15% product from additives (VTAE) need to dispose of or sell to add to asphalt.
- **Extraction**
  -Produce base oil stock and lower capital costs than other re-refining processes
  -High pressure operation and hazardous operation from propane
  -Disposal of oily sludge and of spent clays or spent catalysts
  -High operating costs
  -10 to 15% product from additives (VTAE) need to dispose of or sell to add to asphalt

Economics an example for comparing size and technology

- **Size versus, Operating costs and total costs**
- **Transport costs**
- **Payback in a volatile market**
- **Payback versus size and technology**

Size of plants impact on Operating and Capital costs in the US

Type of process	Distillation-Hydrotreatment			New cracking		
Size in tons per year	40,000	80,000	160,000	40,000	80,000	160,000
Capital estimate US$ in 000	$ 30,000	$ 48,000	$ 76,800	$ 8,000	$ 12,000	$20,480
Operating costs US$ / toms	$ 176	$ 146	$ 127	$ 55	$ 41	$ 33
Capital + operating costs	$ 279	$ 229	$ 193	$ 104	$ 79	$ 66

Transport costs for oil
North America

- Trucking for collection (Radius 300 to 500KM) = $.20 to $.50 per gallon or 60 to 100 dollars a ton.
- Rail tank car (1000 to 3000 km)= $10 to $17 per barrel or $70 to $120 dollars a ton.
- Barge (near water)= $4 to $6 per barrel or $30 to $45 USD

- Population needed for used oil:

5.5 kg/year per person new oil result in 73% to be collected and for used oil plant can collect X% in a given territory (example 70%):

  - 40,000 tons= 14 million people
  - 80,000 tons = 28 million people
  - 160,000 tons= 56 million people

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Comparison increase in efficiency versus transport costs

- Double capacity from 40,000 to 80,000 tons=
  - Distillation- hydrotreating total cost savings= $50/ton versus increase costs of transport ??% of 80 USD.
  - Cracking total cost savings= $24/ton versus increase costs of transport??% of 80 USD
- Double capacity from 80,000 to 160,000 tons=
  - Distillation- hydrotreating total cost savings= $36/ton versus costs of transport ??% of 80 USD.
  - Cracking total cost savings= $14/ton versus costs savings of ??% of 80 USD

High volatility of oil prices

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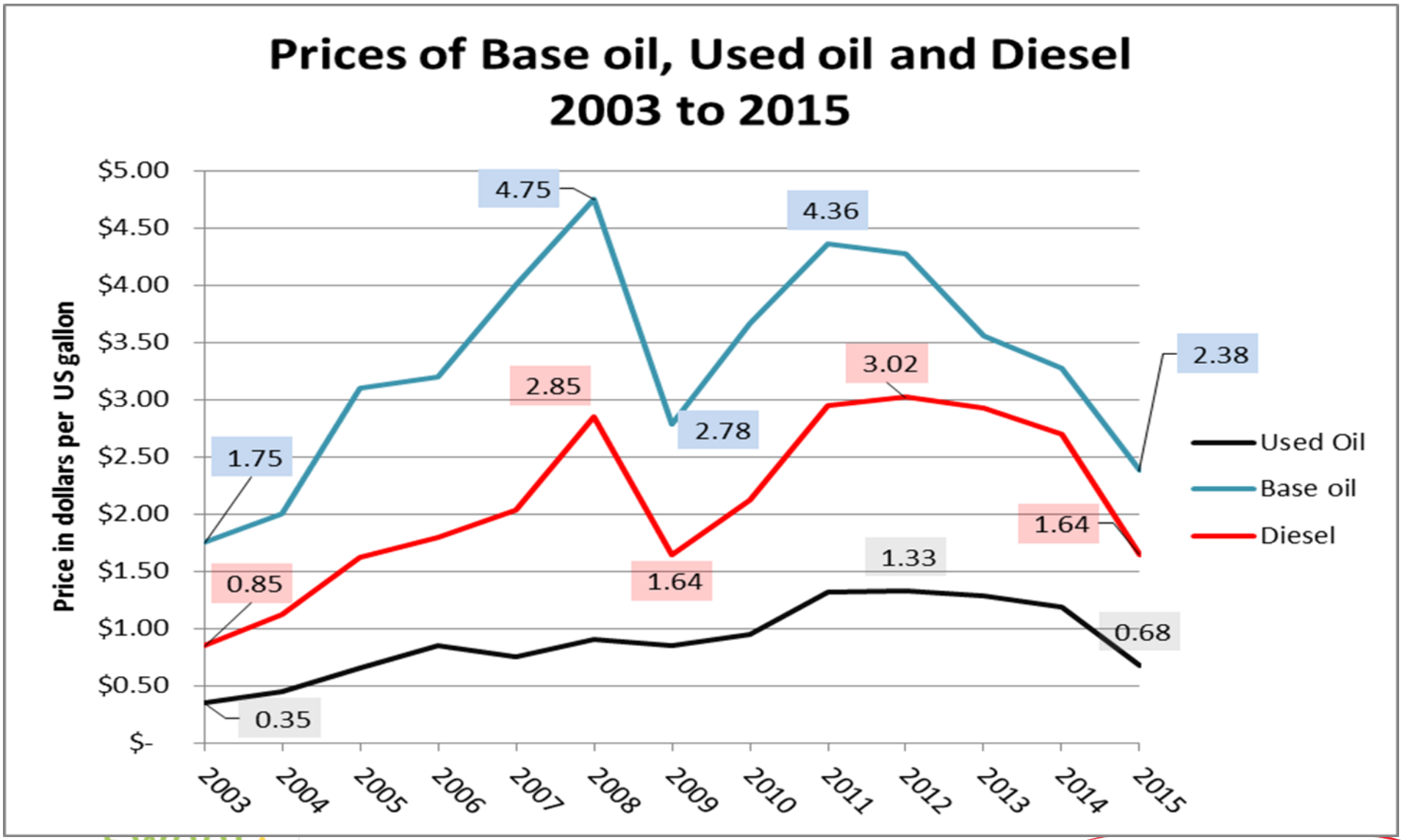
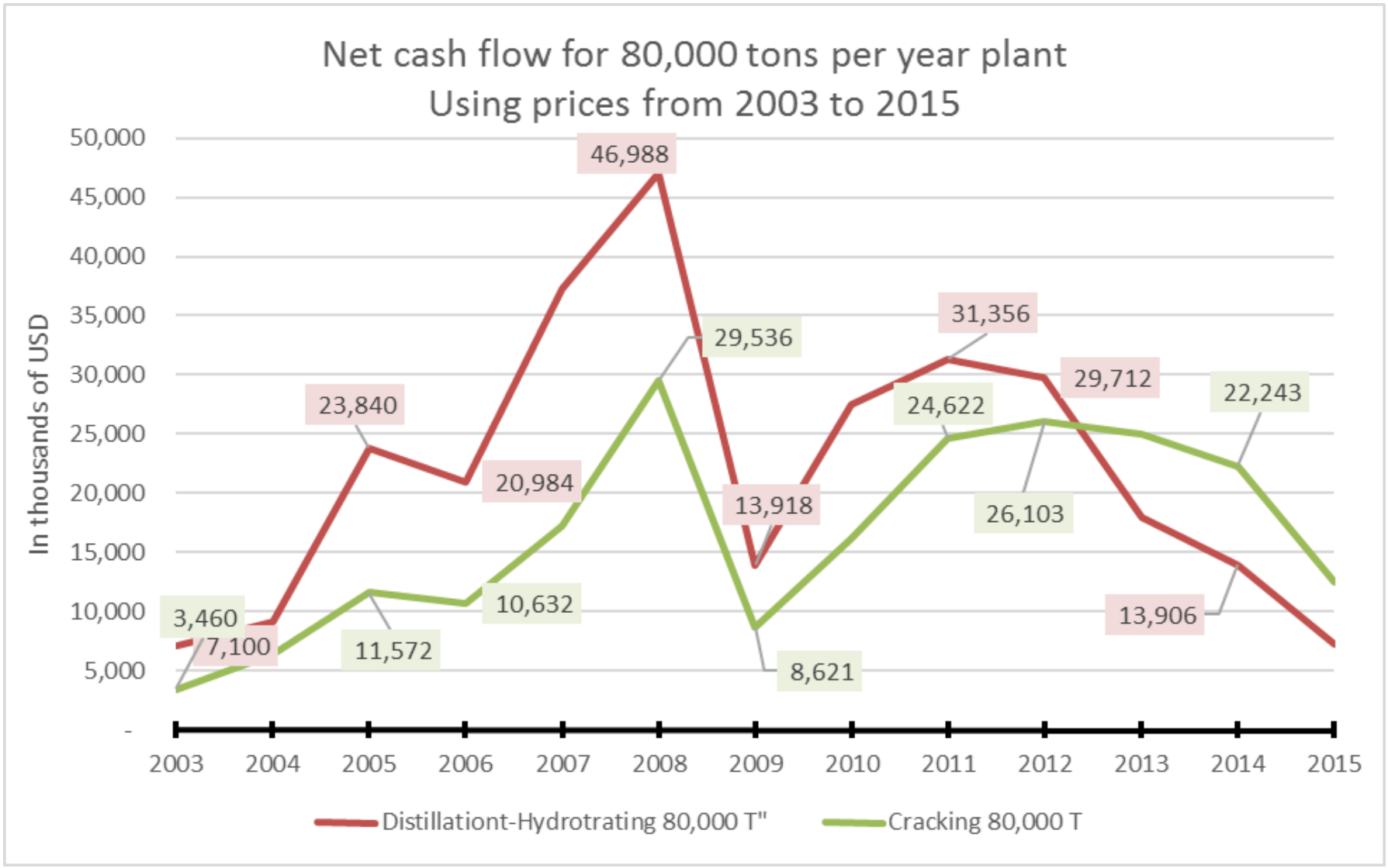


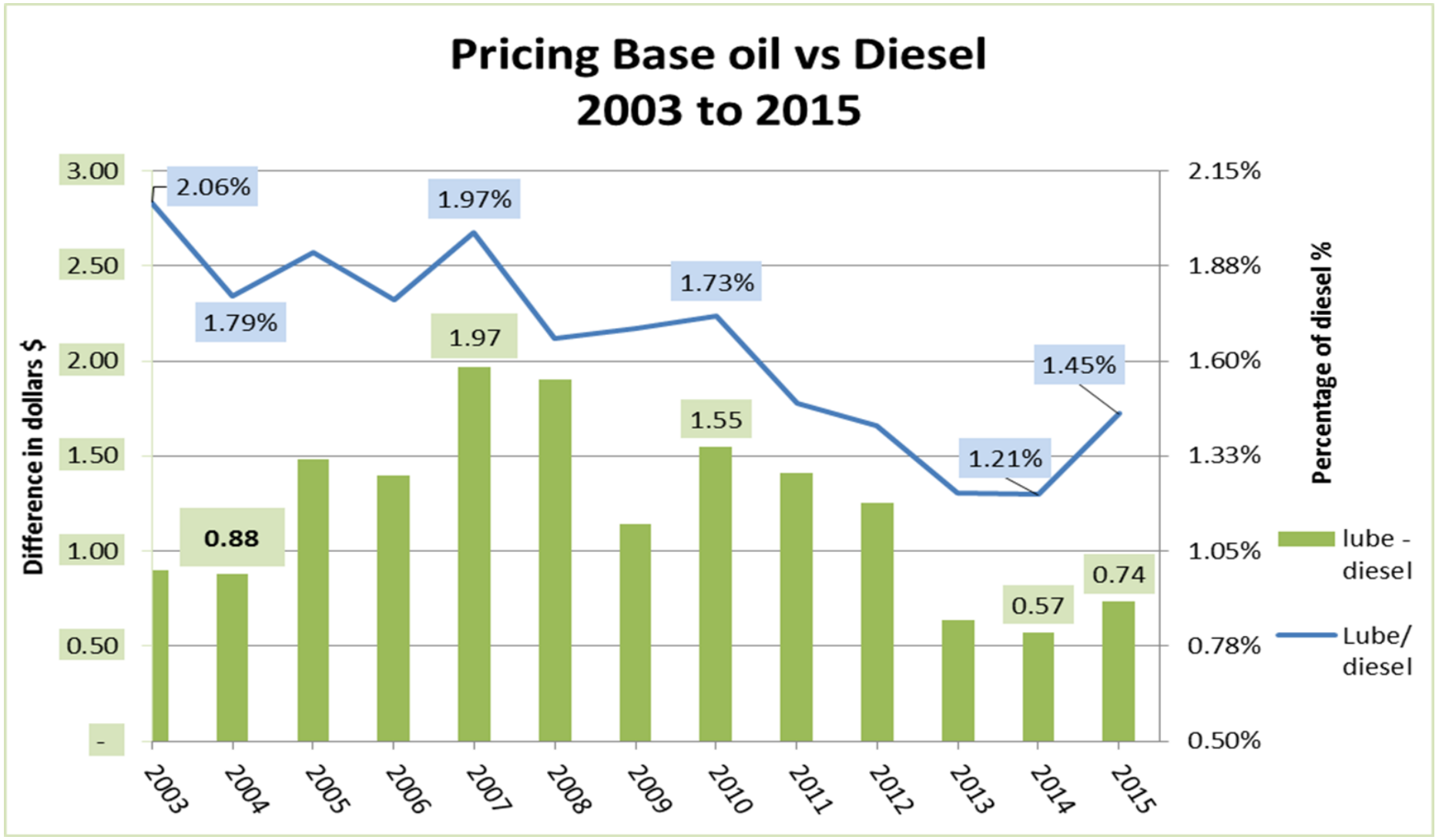
High volatility of oil prices

Impact on net cashflow

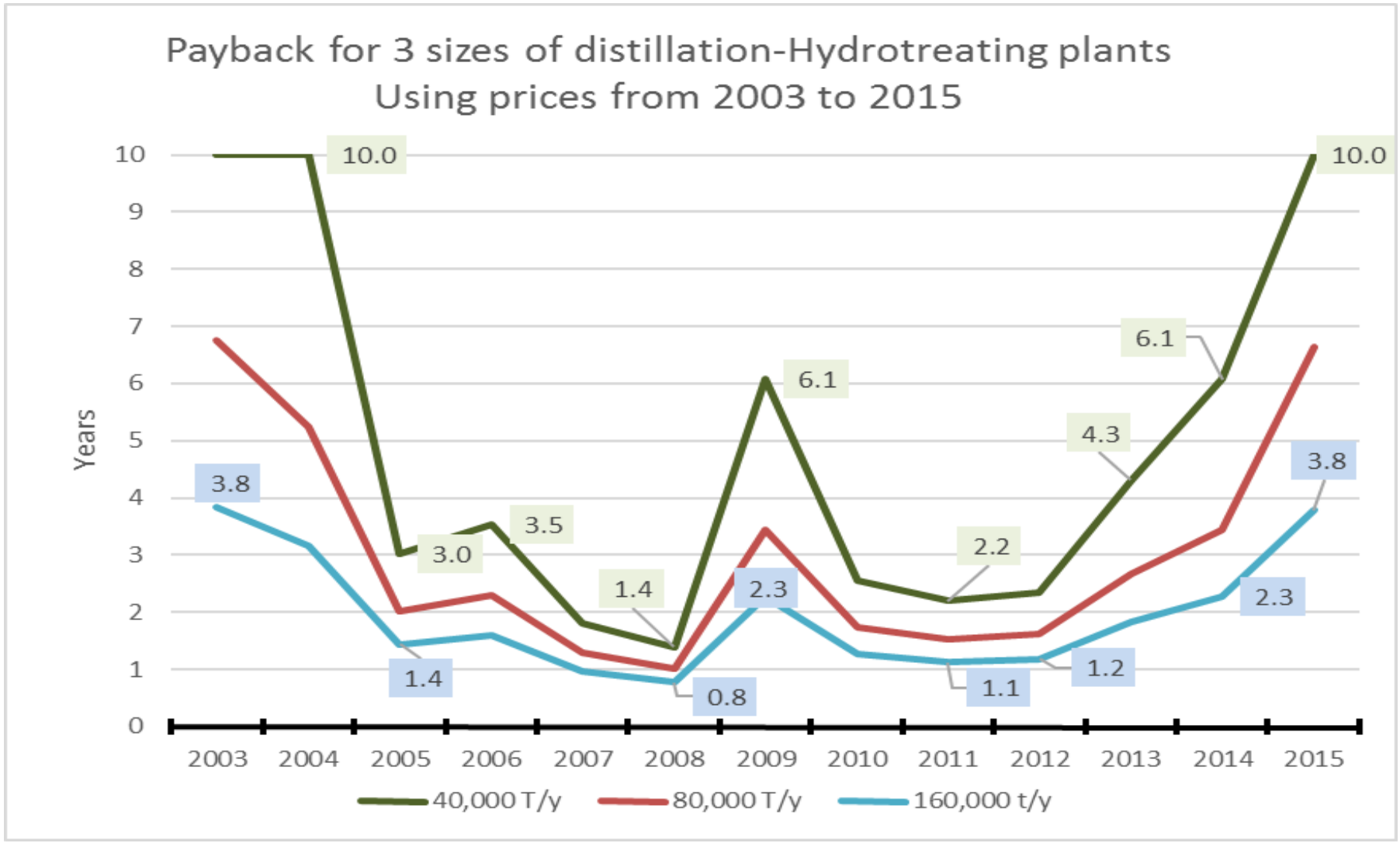


High volatility of oil prices

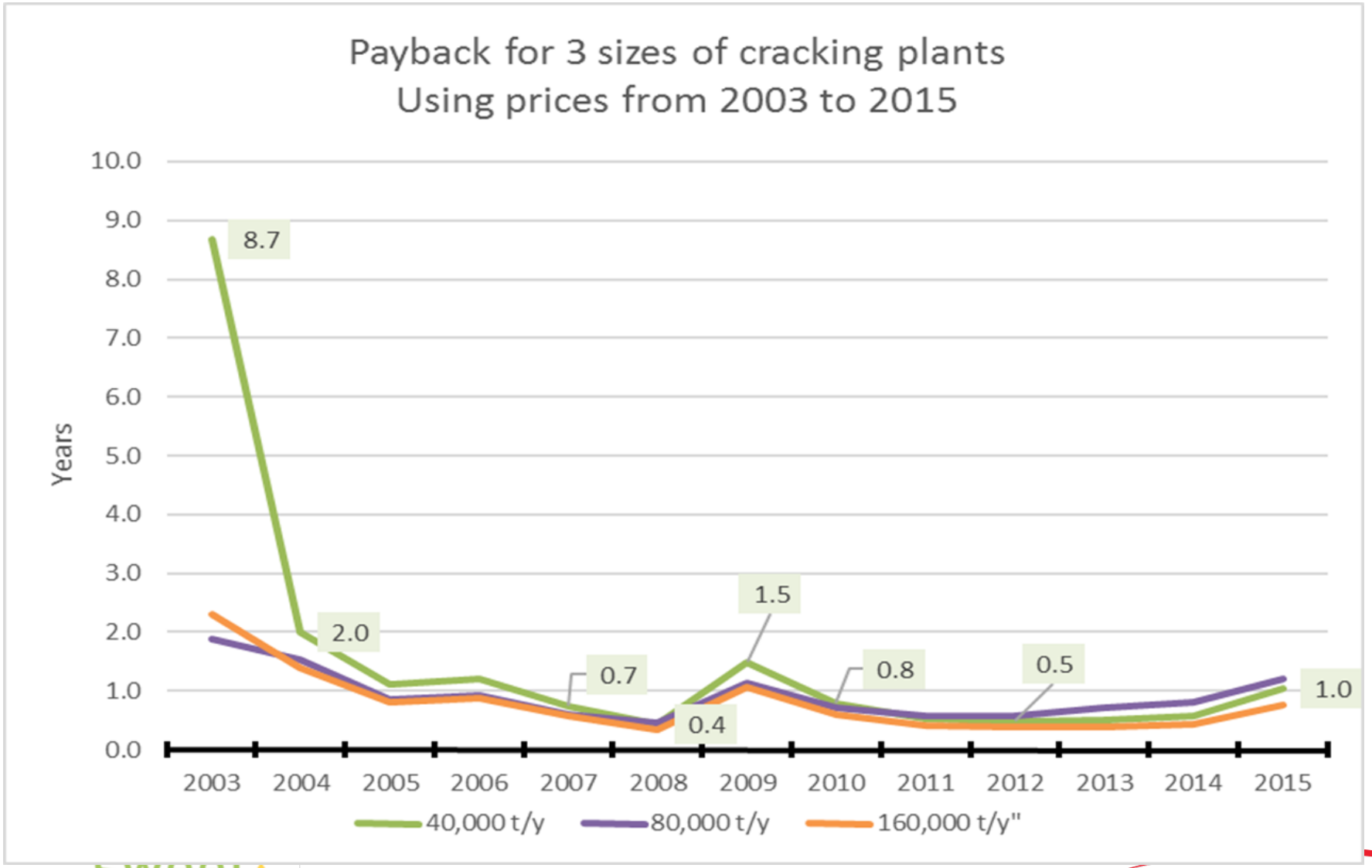
Base oil versus Diesel over 12 years



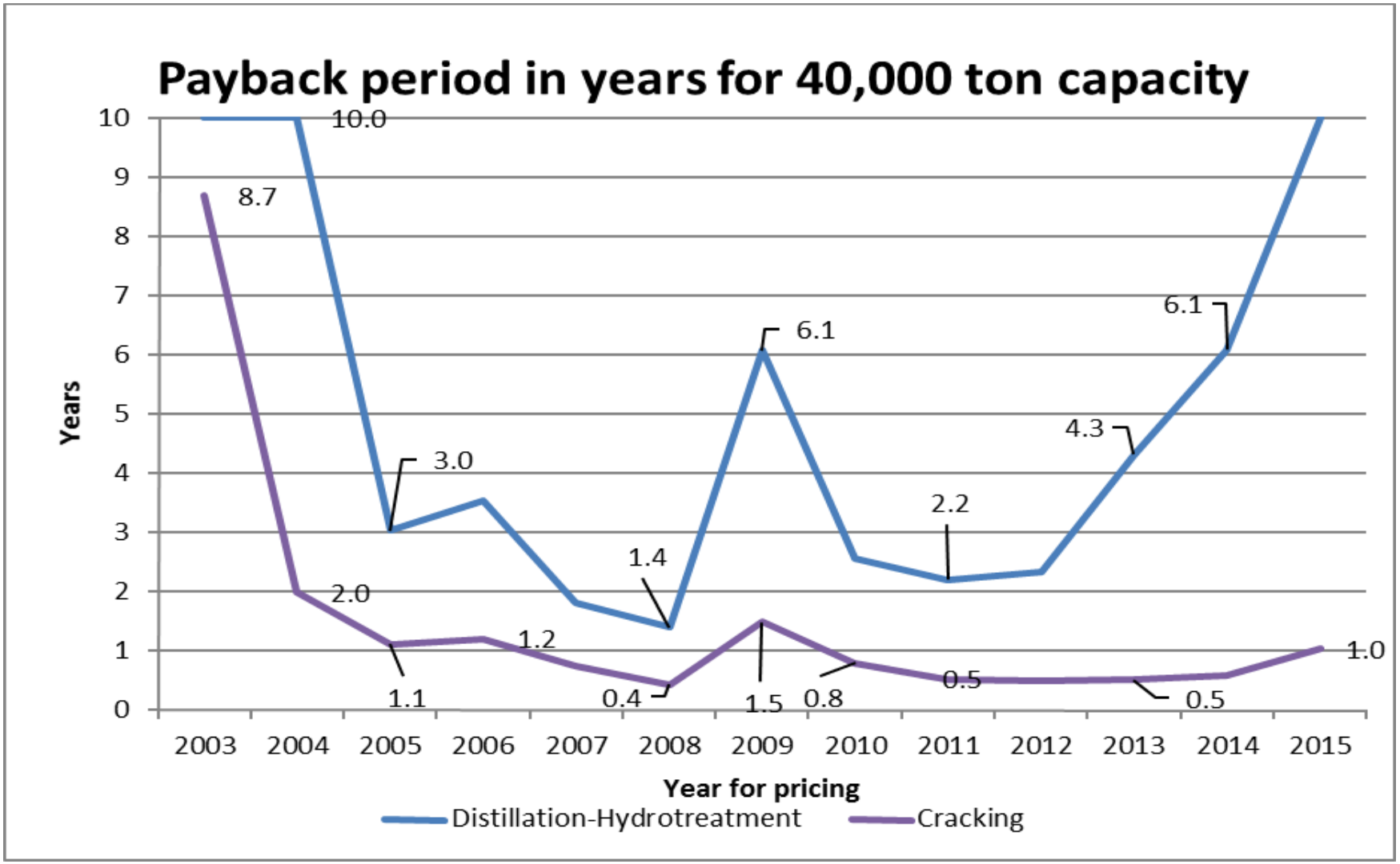
High volatility impact depending on size Distillation-Hydrotreatment



High volatility impact depending on size Cracking



High volatility impact on payback period Distillation-Hydrotreatment vs cracking



Used oil treatment in volatile and low carbon environment

- Cost of transport can be as important or more important than the cost treatment of the used/waste oils.
- Avoid “silo” solutions. Used oil treatment plant economics are affected by the range of feedstock and markets for their products, transport costs (logistics) and regulation which have evolved rapidly over the years. It is important to consider all factors when looking at different technologies or solutions.
  - The bigger the plant the lower the capital and operation costs per ton but for used oil this should be compared with transport costs given a bigger collection area.
- Smaller plants which takes less capital reduces the risk but limits the type of products that can be produced.
- Used lubricants is very different than Base oils.
- In environment economics are important and should be looked at throughout the life cycle of a product.

New cracking technology

- Can be added to existing Base oil and VGO operations to increase flexibility and profitability just like in refineries.
- Can take a wider variety of feedstock
  - Lower costs of feedstock including VTAE
  - Smaller collection area= reduces transport costs and carbon emission
  - It reduces the incineration of those oils and the improper disposal of what is seen as no value waste.
- Increases flexibility and long term profitability of treatment of used and waste oils
- We have heard some people saying that the bigger is better when talking about the size of the treatment plant. Comparison with the base oil market is important. In used/waste oils this can lead to costly mistakes.
- New technology permits to have better economics and adapt to a limited feedstock in a volatile pricing environment.