

MPC at Statoils Kalundborg Refinery



17th Nordic Process Control Workshop

Technical University of Denmark, Kgs Lyngby, Denmark
January 25-27, 2012

Anne-Katrine Ipsen, Advisor Refining

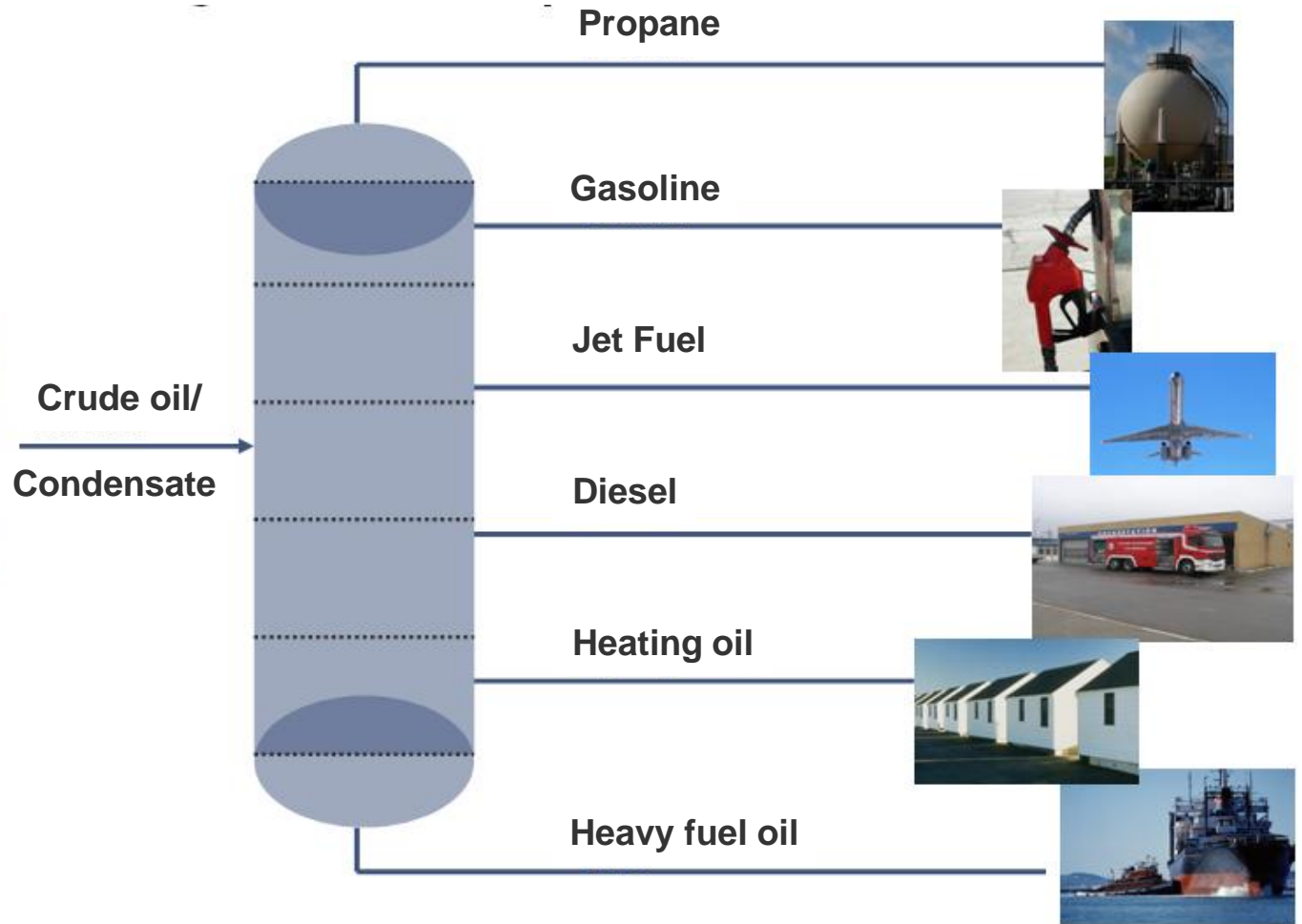
Content of presentation

1. About Kalundborg Refinery
2. APC history
3. Statoils InHouse MPC tool Septic
4. Examples of MPCs
5. GORTO – Gas Oil Dynamic RTO

First a little about Kalundborg Refinery

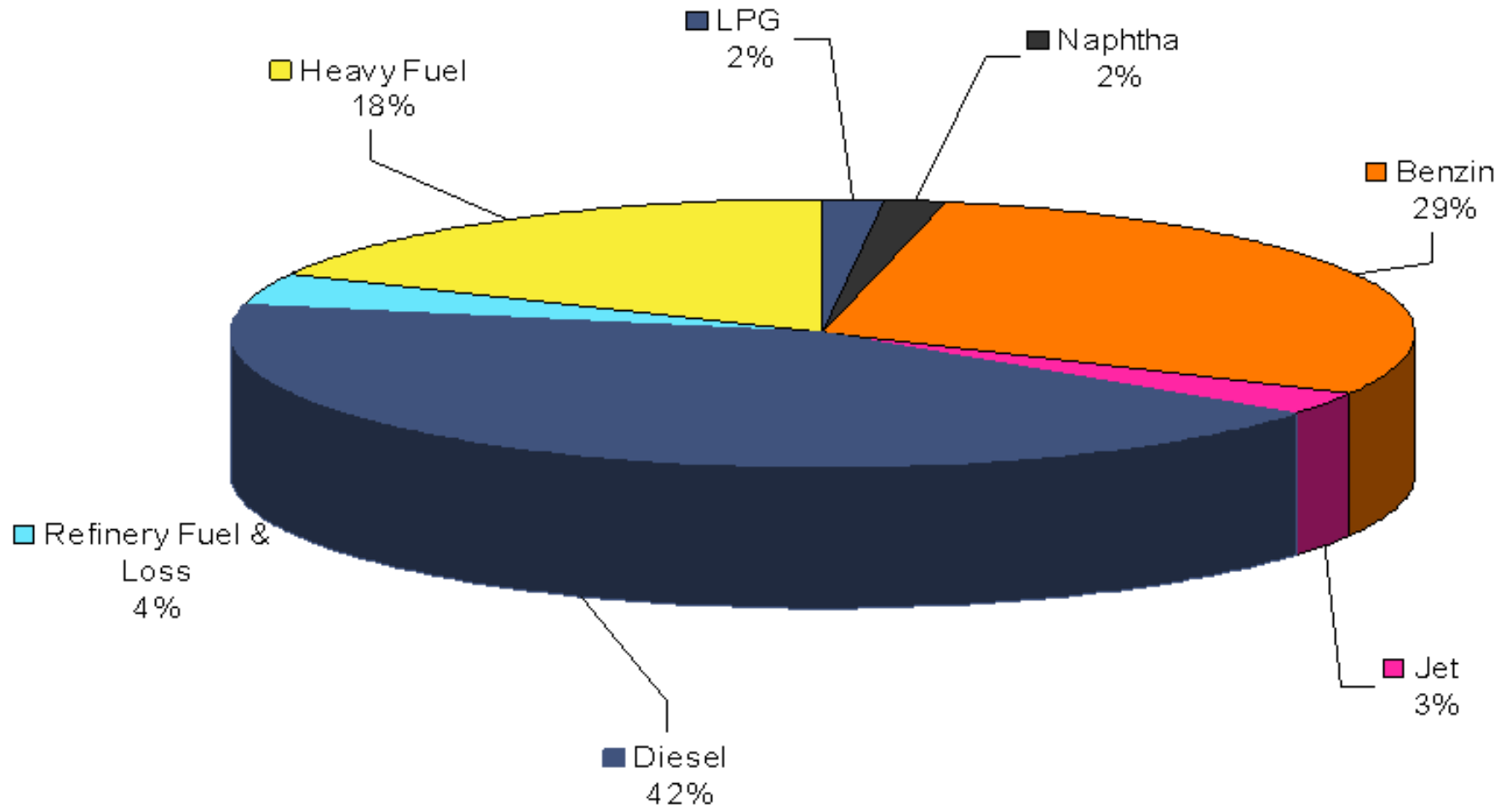


Statoil Kalundborg – Main products



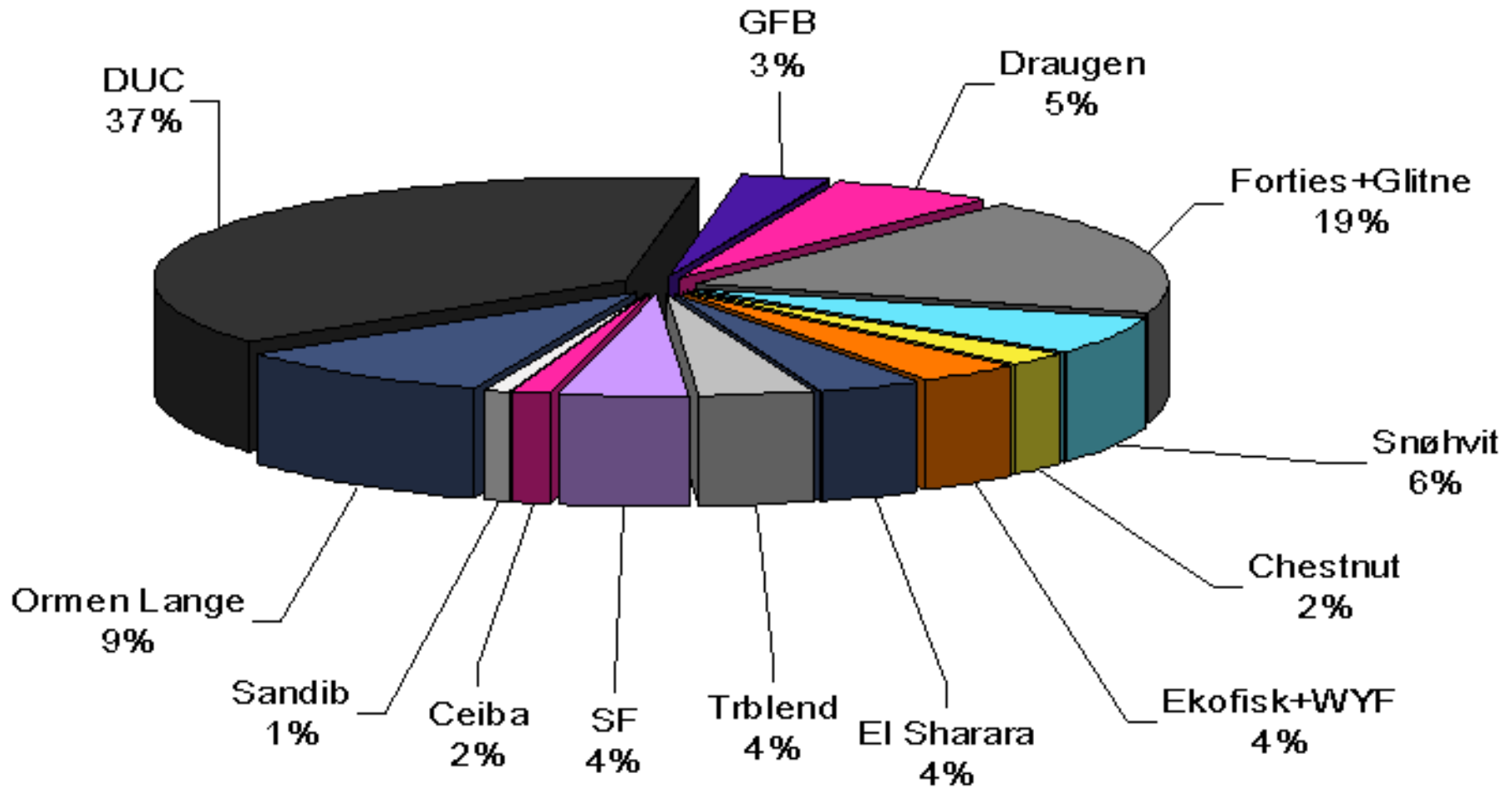
Yearly production 2010

2010 total production: 4755 Mill tons



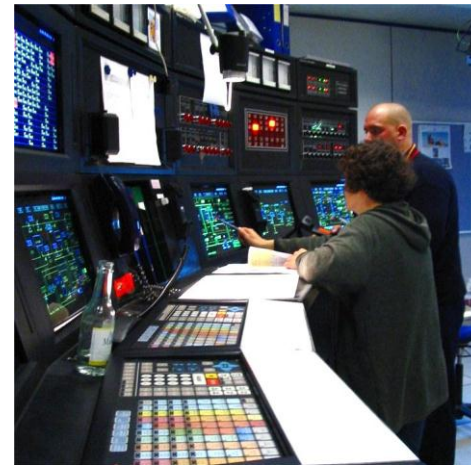
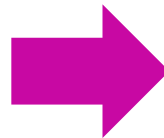
Crude oil/ Condensate throughput 2010

2010 total throughput: 4521 Mill tons

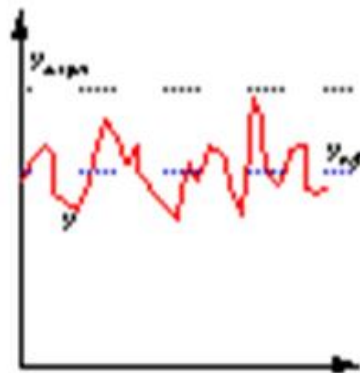
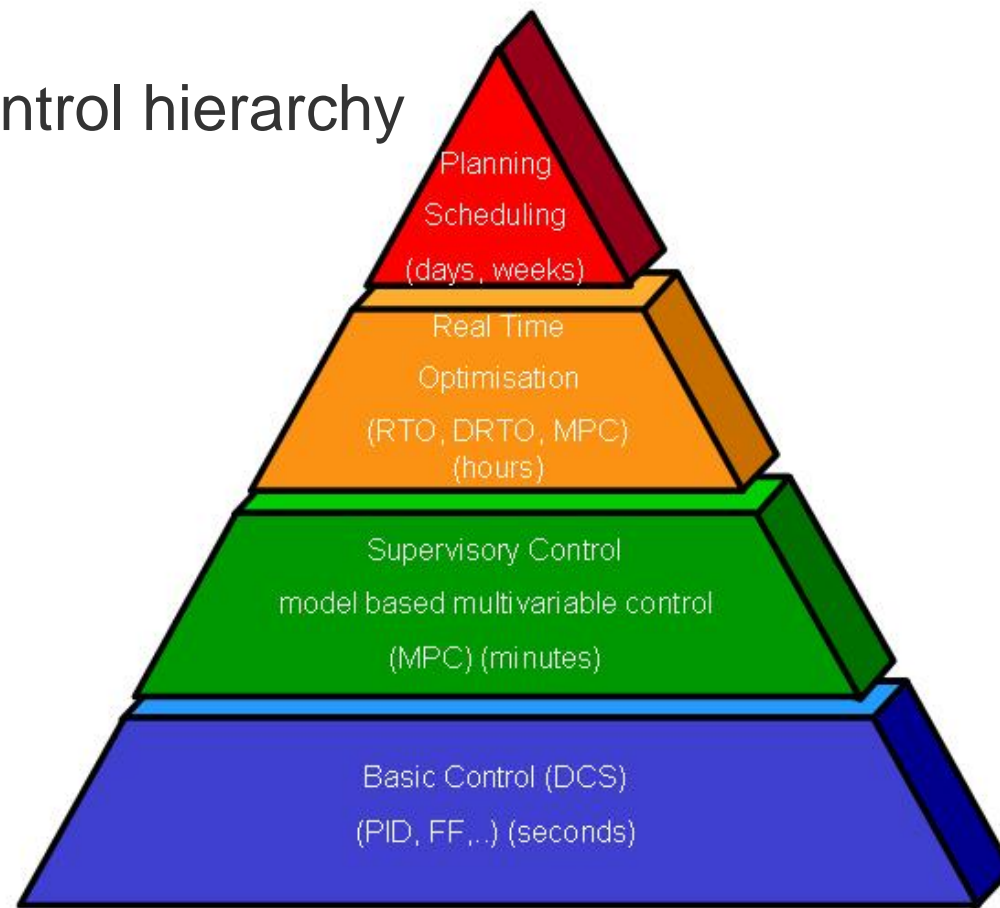


APC history

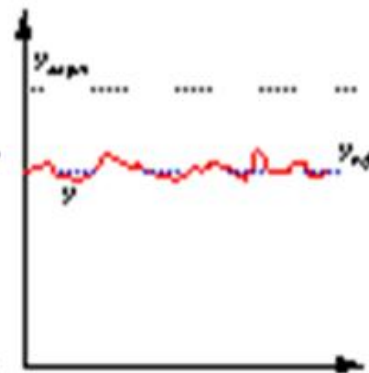
- Honeywell DCS from 1986
- Implementation of conventional APC in cooperation with Exxon
- MPC study by Exxon 1995 – first MPC planned on Condensate Fractionator, using AspenTech DMC+. Never completed due to technical problems.
- First MPC implemented in 1999 – using SEPTIC, close cooperation with F&T
- Kalundborg MPC strategy in 2001
- Continued MPC implementation 1999-201x



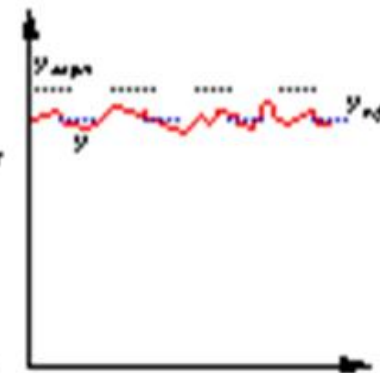
The process control hierarchy



Basic Control



MPC

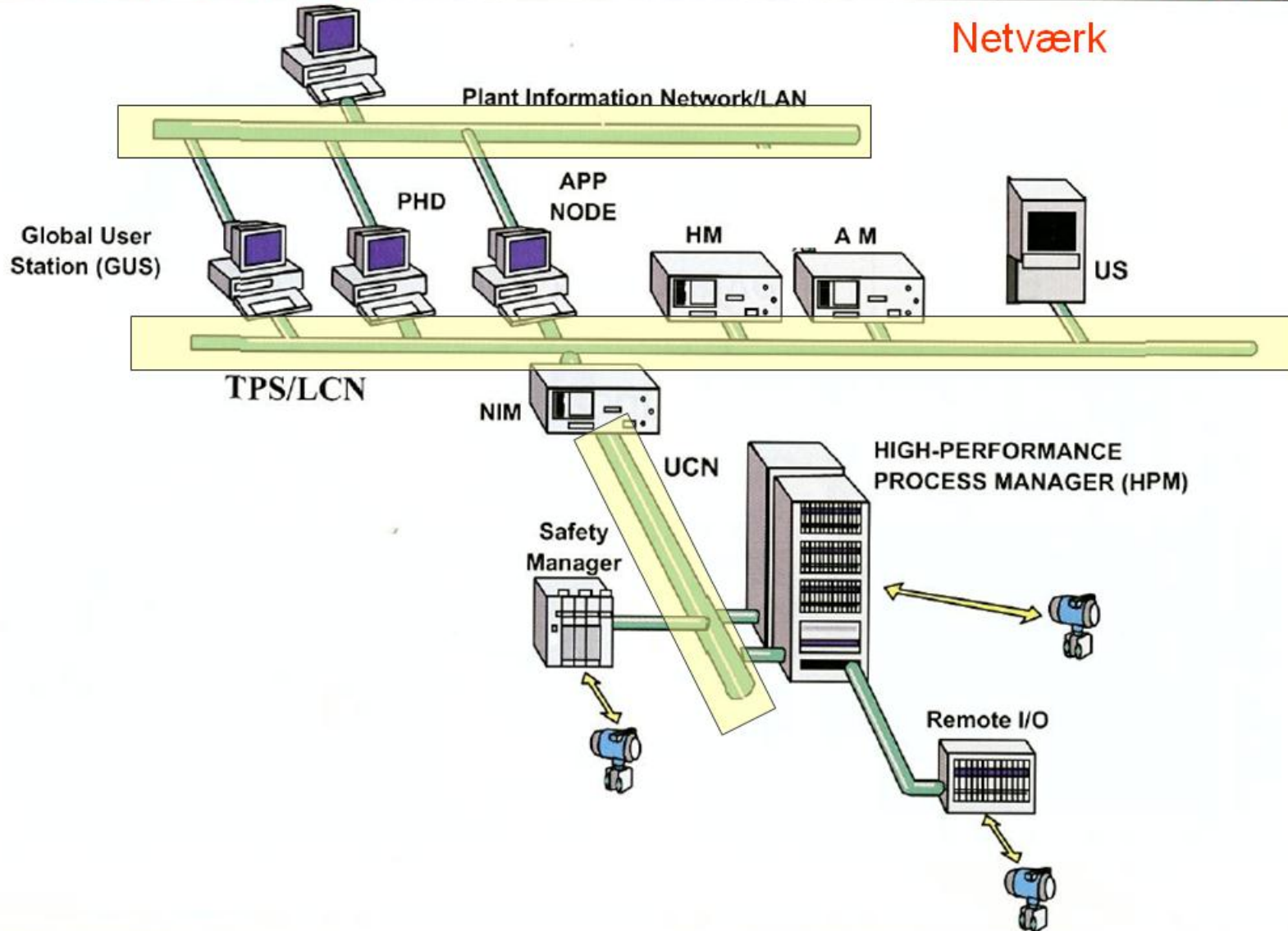


RTO - DRTO - MPC

Distributed Control System

Architecture Overview

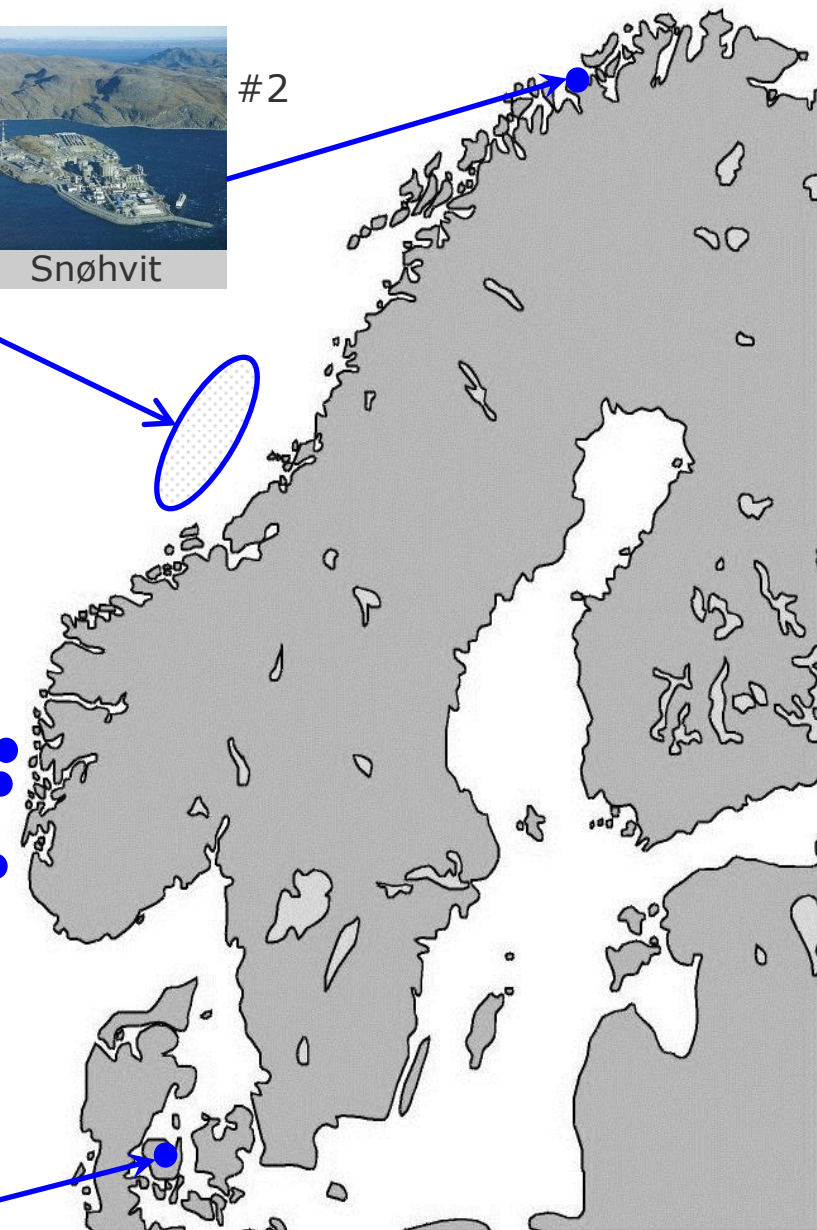
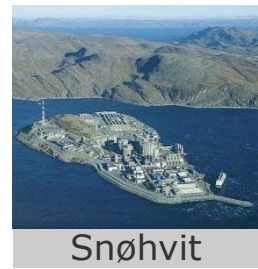
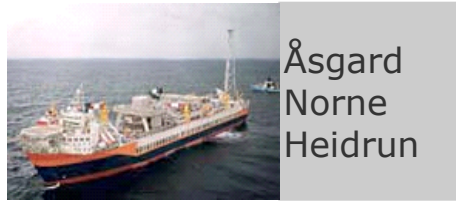
Honeywell



SEPTIC

Statoil Estimation and Prediction Tool
for Identification and Control

Sept-2011:
80 Applications



Note: oppdatert SM og KLB sept 11

Applications

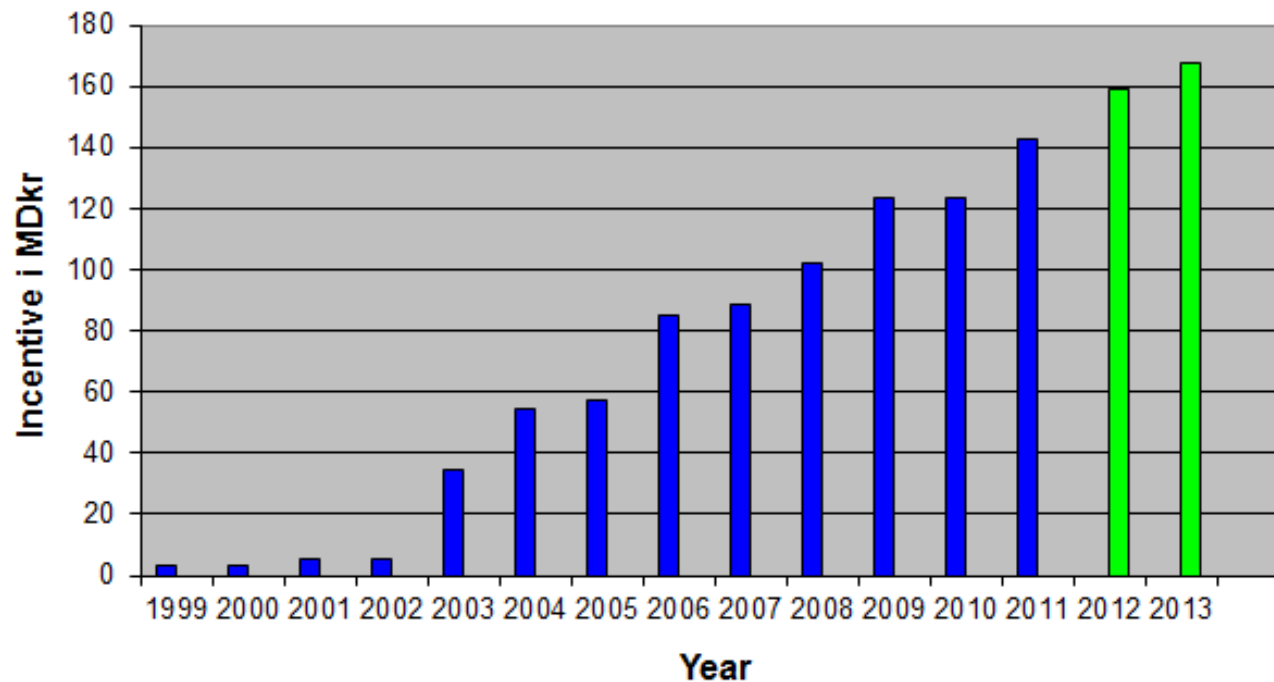
- Oil Refining (Mongstad and Kalundborg)
 - Distillation
 - Product blending (Gasoline and Gas Oil)
 - Steam production and consumption
 - Crackers, reformers, hydrotreaters
 - Heat exchanger network (RTO)
 - Optimization (RTO/DRTO)
- Gas Plants (Kårstø, Kollsnes, Snøhvit)
 - Distillation
 - Gas quality
 - Pipeline pressure control
 - Optimization
- Offshore
 - Extended slug control, buffering
 - Crude mixing
 - Produced Water Reinjection
 - Gas quality



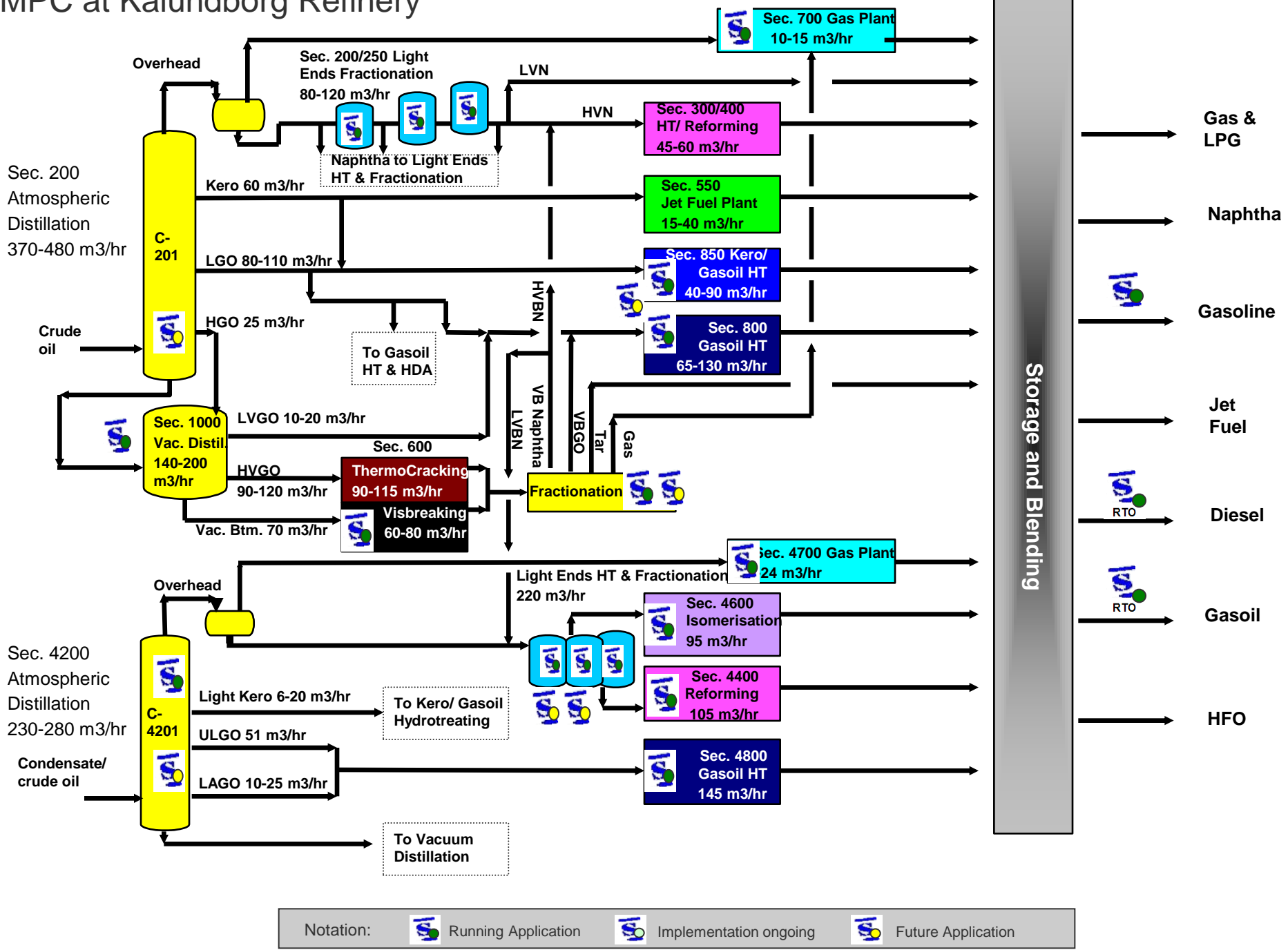
SEPTIC
Statoil Estimation and Prediction Tool
for Identification and Control

2012 APC status

- 18 MPCs running – 124 MVs, 266 CVs
- gasoil production and blending dynamic RTO (GORTO)
- gasoline batch blending
- total MPC incentive 142 MDkr/year



MPC at Kalundborg Refinery

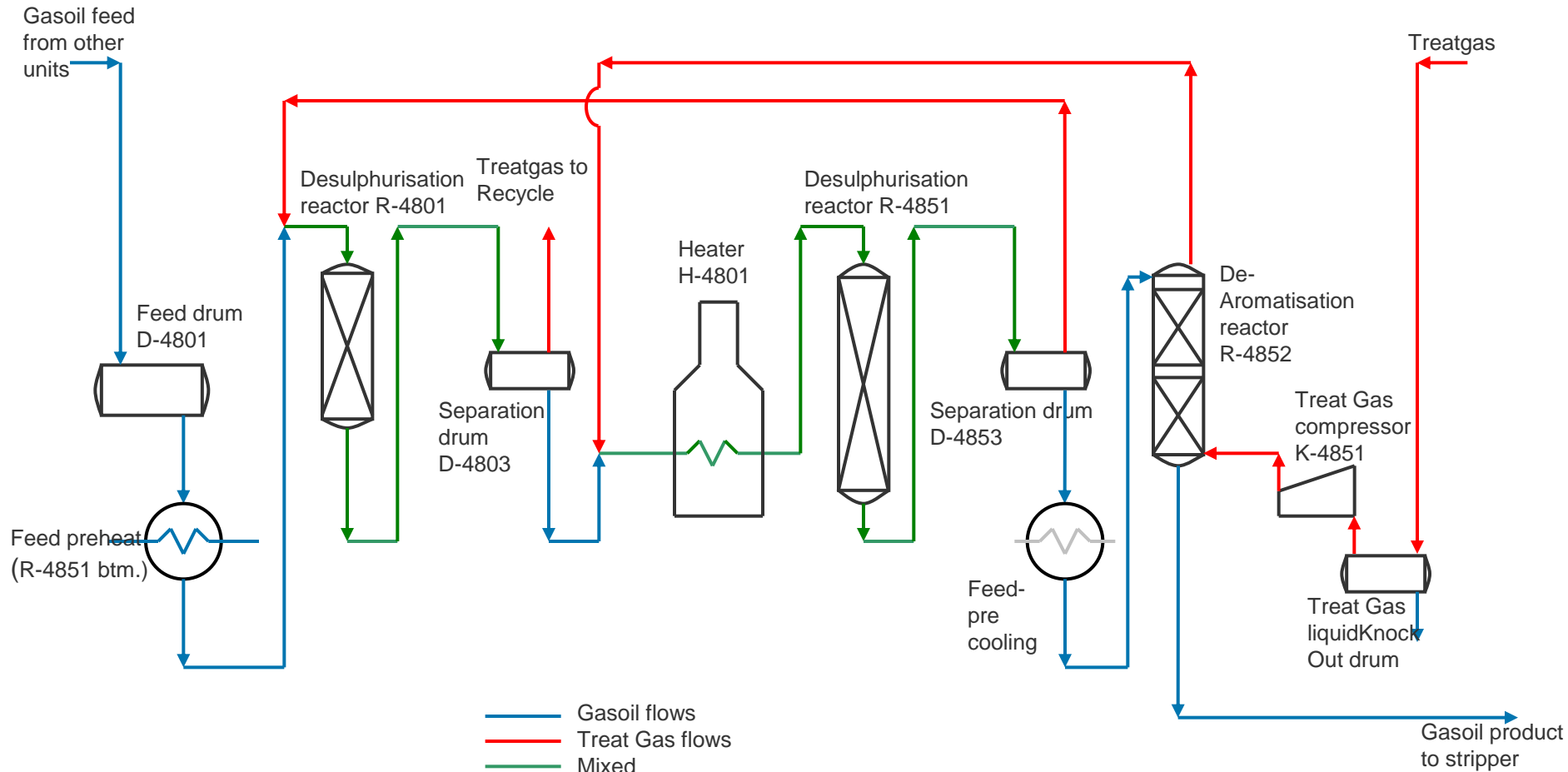


MPC example: Kalundborg Synflex Unit

The purpose of this unit is desulphurisation and dearomatisation of diesel.
One product is swedish City diesel.

There are 2 catalytic desulphurization reactors and 1 catalytic dearomatisation reactor.
The processes uses hydrogen.

Reactor pressure 60 barg. Reactor temperature app.. 350°C. Design throughput 145 m3/hr.

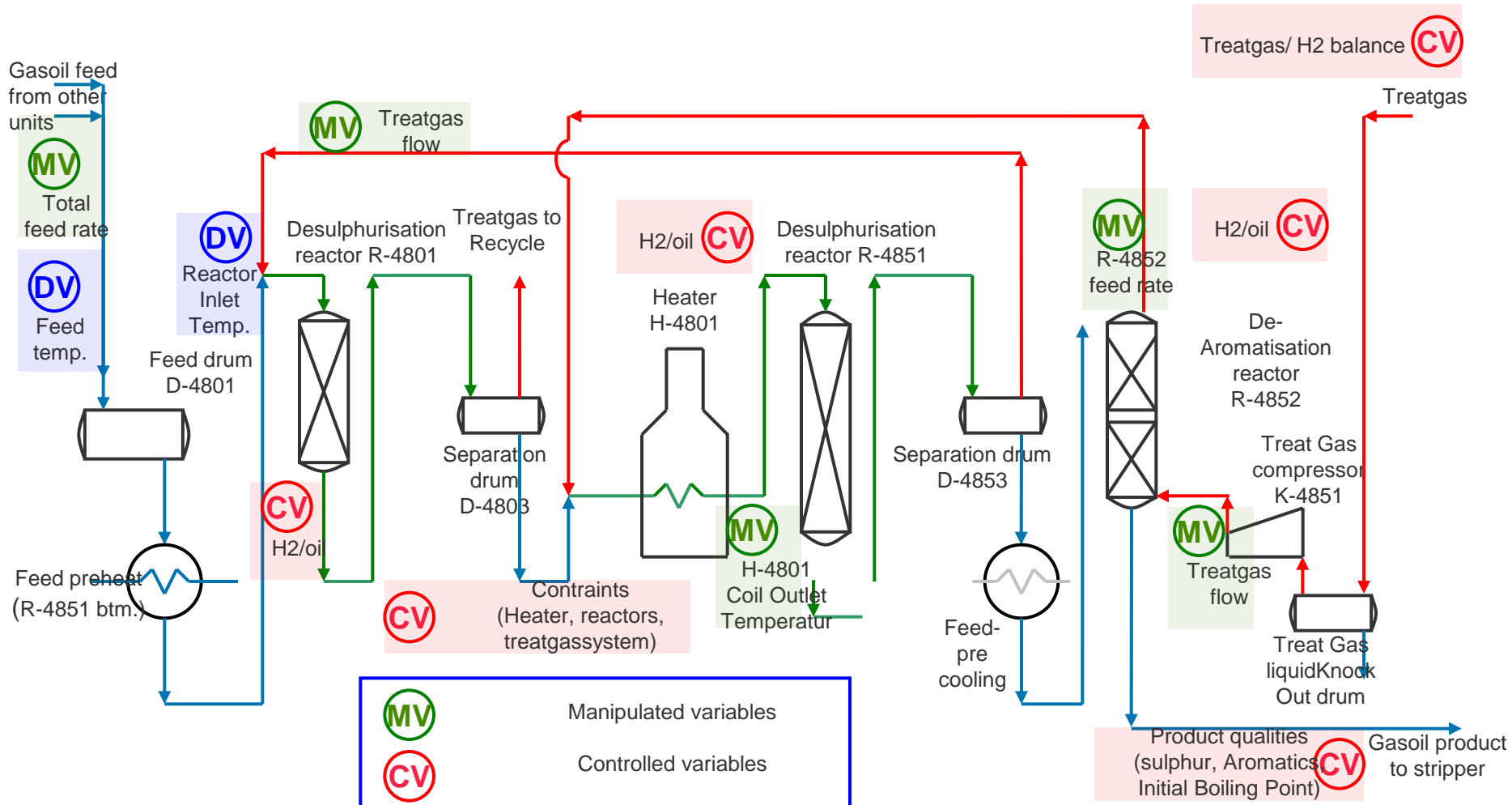


MPC example: Kalundborg Synflex Unit

Advanced process control in this plant is 1 MPC for total optimisation.

- Optimises unit throughput
- Controls all relevant product qualities
- Respects all relevant constraints - reactors, furnace, treatgas system

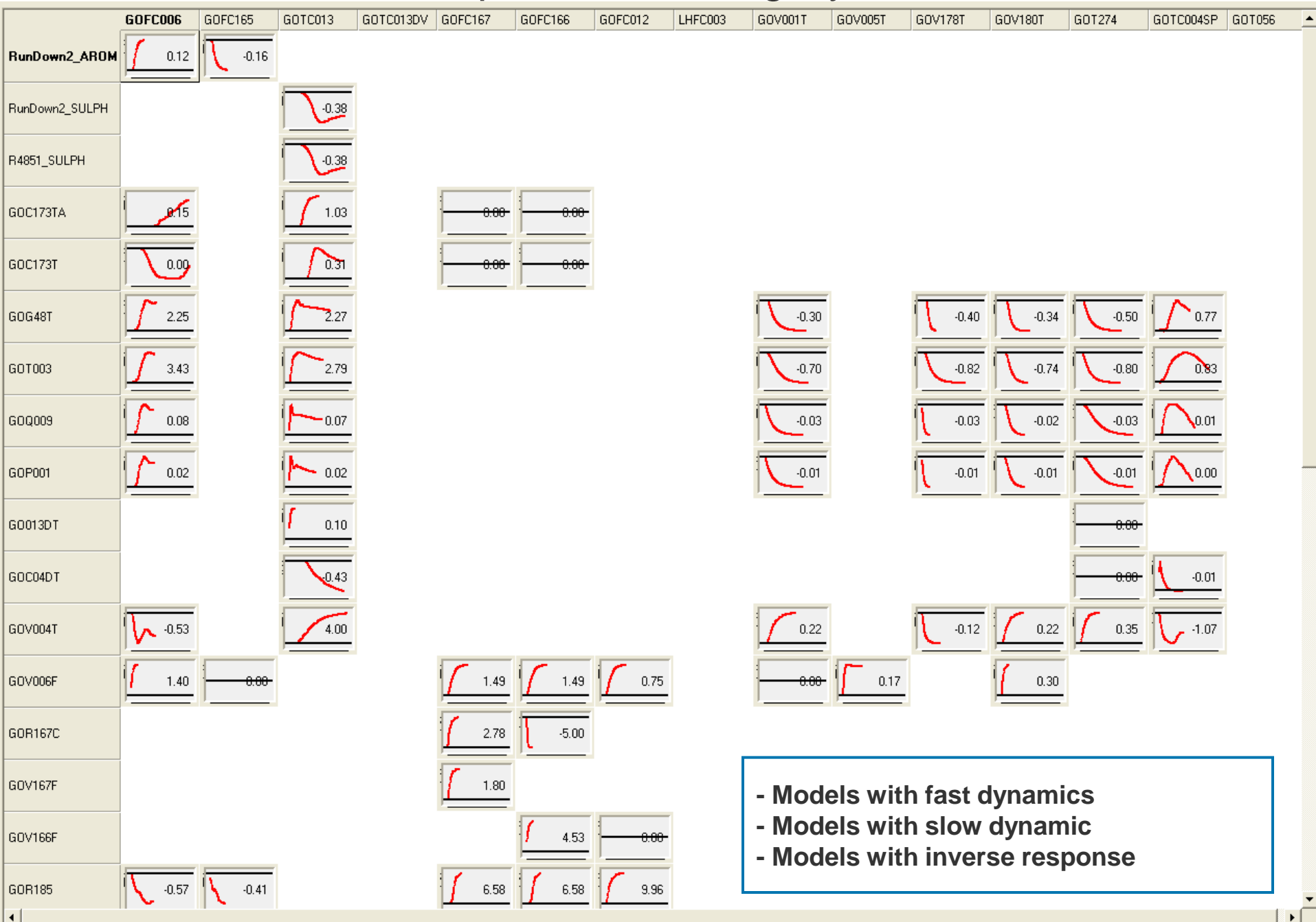
- 10 MVs
- 29 CVs
- 2 DVs



MPC example: Kalundborg Synflex Unit



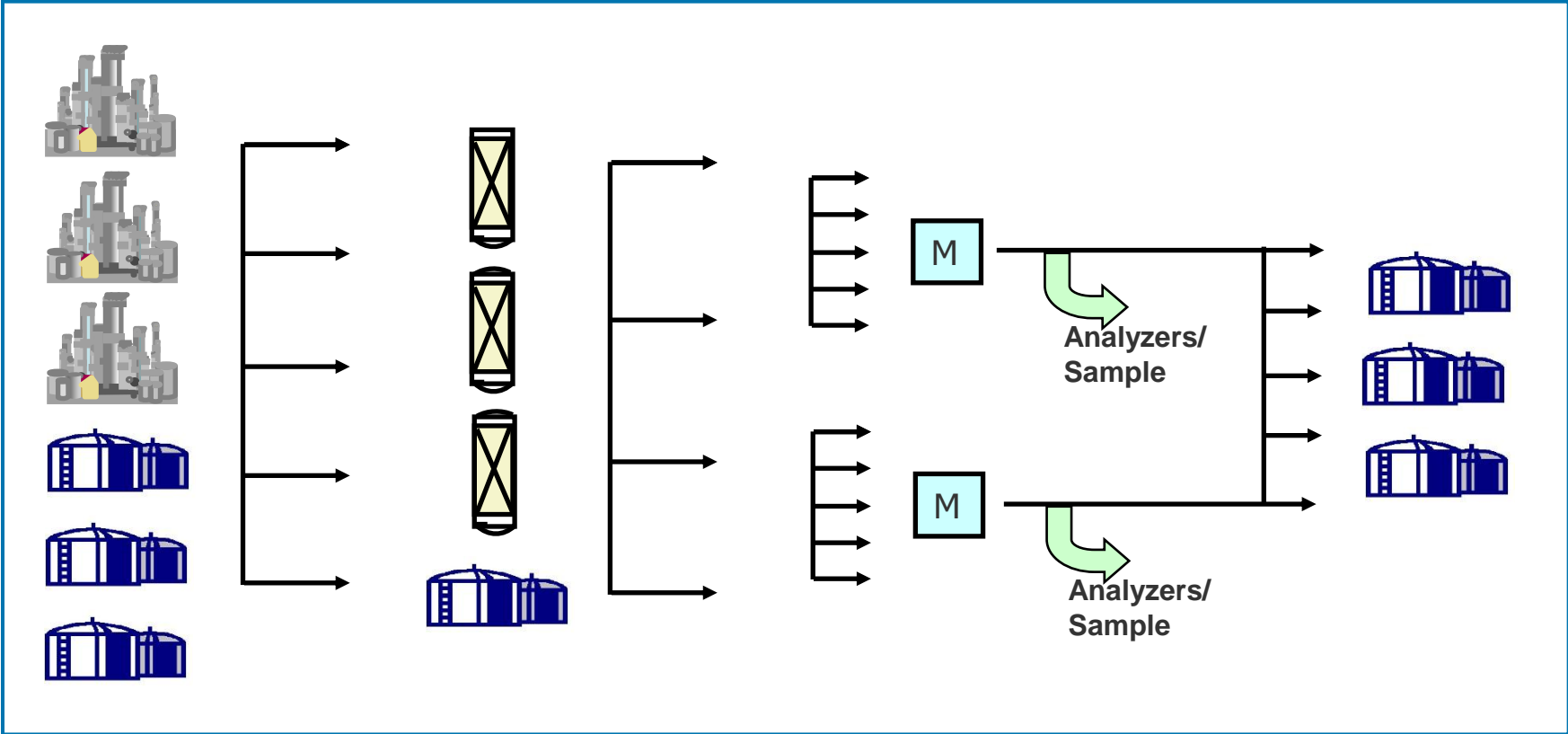
MPC example: Kalundborg Synflex Unit



- Models with fast dynamics
- Models with slow dynamic
- Models with inverse response

GORTO - Gas Oil Dynamic RTO

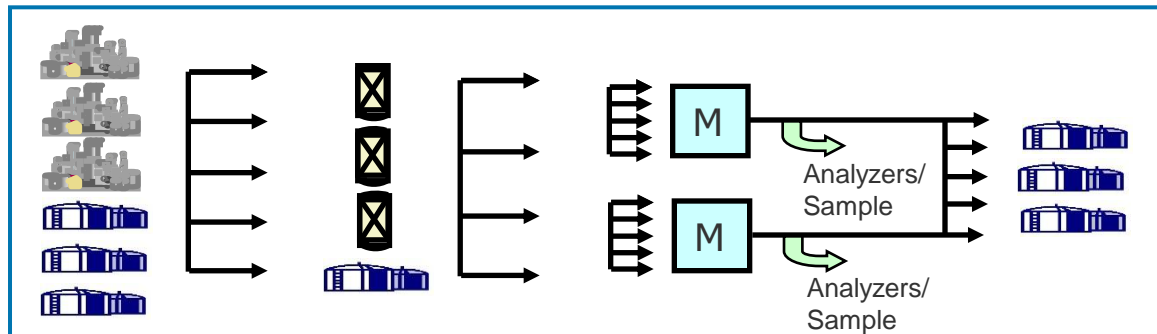
Kalundborg Gas Oil Production:



GORTO - Gas Oil Dynamic RTO

Objectives:

- Maximizing the total Gas Oil Production
- Coordinating the operation of Main Fractionators
- Controlling and coordinating the gas oil Hydrotreaters
- Minimizing Give-Away on the end-products
- Minimizing production of lower valued heavier products
- Minimizing production costs
- Maximizing reactor catalyst cycle time
- Managing the rather large time delays throughout the production processes.



GORTO - Gas Oil Dynamic RTO

GORTO parts:

- 100+ Product Quality estimators on all Fractionator and Hydrotreater Streams
- Automatic use of Lab data
- Automatic Gas Oil lineup check
- Automatic coordination of Fractionator MPC's
- MPC's on Gas Oil Hydrotreaters
- Automatic control of Gas Oil Blendstocks from Tank
- Tank Quality Tracking & Control on Gas Oil Feed Component Tanks
- Tank Quality Tracking on Gas Oil Product Tanks

- Number of Variables
 - Manipulated Variables (MV's): 39
 - Controlled Variables (CV's): 97
 - Disturbance Variables: 44
 - Logic Variables (i.e. line-up indicators): 37

GORTO - Gas Oil Dynamic RTO

- Statoil presented GORTO at the European Refining Technology Conference in Lisbon in 2008



**The European Refining
Technology Conference**

Controlling Gas Oil Production and Blending via MPC & Dynamic RTO

Authors

Torben Ravn Andersen¹, traan@statoilhydro.com,

Anne-Katrine Ipsen¹, d01ai@statoilhydro.com,

Jesper Riis Kristensen¹, djrk@statoilhydro.com,

Morten Fredriksen², mofr@statoilhydro.com,

Stig Strand², stra@statoilhydro.com

¹ StatoilHydro A/S Refinery, Process Control Dept.,
Melbyvej 17, 4400 Kalundborg, Denmark
Ph/Fax: +45 5957 4500 / +45 5951 7081

² StatoilHydro Research Centre, Process Control Dept.,
Rotvoll, Arkitekt Ebbells vei 10, 7005 Trondheim, Norway
Ph/Fax: +47 7358 4011 / +47 7396 7286

Keywords

Dynamic RTO, Coordination of main fractionator MPC's, Coordination of gas oil hydrogen processing units, Gas oil rundown blending, Soft sensors, On-line updated stream qualities, Data quality and validation

There's never been a better
time for **good ideas**

MPC at Statoils Kalundborg Refinery

Anne-Katrine Ipsen
Advisor Refining
E-mail address d01ai@statoil.com
Tel: +45 59 57 45 37

www.statoil.com