Distinguished Lecturer Program

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Distinguished Lecturer Program

Moving the Frontiers in Artificial Lift Technology in Mature Field Operations

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Society of Petroleum Engineers
Distinguished Lecturer Program
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Agenda

- Introduction
- Challenges in mature field operations
- Examples of smart technical solutions
- Intelligent material selection
- Economic evaluation
- Conclusion

Introduction

- Mature field operations will become an increasingly important theme for the future.
- Everyone in the E&P Industry will be faced with the challenges of delivering highest possible recovery factors in difficult environments.
- No single simple solution will solve the problems
- A basket of mutual supportive technologies is necessary

Challenges in Mature Field Operations

- Small margins and limited budget
- Production decline in tail-end phase = economic Constraints
- High water cut = high lifting & water treatment costs
- Corrosion (high water cut with CO_2) = short meantime between failures & loss of integrity
- Erosion (sand production) = short meantime between failures & loss of integrity

Principle: Making the Most of What You Have

Guideline: Reduce remedial workovers to free more budget for production enhancement measures

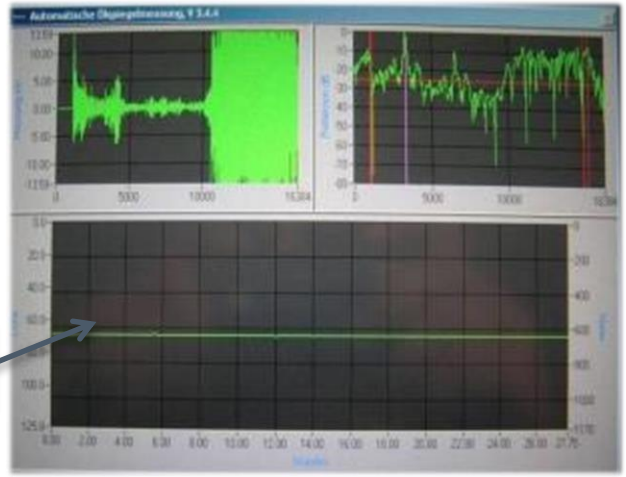
- Smart Technology
  - Advanced draw-down control
  - Electronic Rod Rotator
- Intelligent Material Selection
  - Corrosion Control
  - Sand Control
  - Abrasion Control
    - Poly-lined Tubing
    - Sinker Bars
    - Spray-metal Couplings

SELECTION OF SMART TECHNICAL SOLUTIONS

Continuous Fluid Level Measurement

- Based on radar technology
- Fluid level identification by signal pattern analysis (including frequency analysis)
- Easy to install at the wellhead without workover
- Relative accuracy of measurement +/- 3 meter (10 ft) (at one minute intervals)
- Very effective in combination with Variable Speed Drives

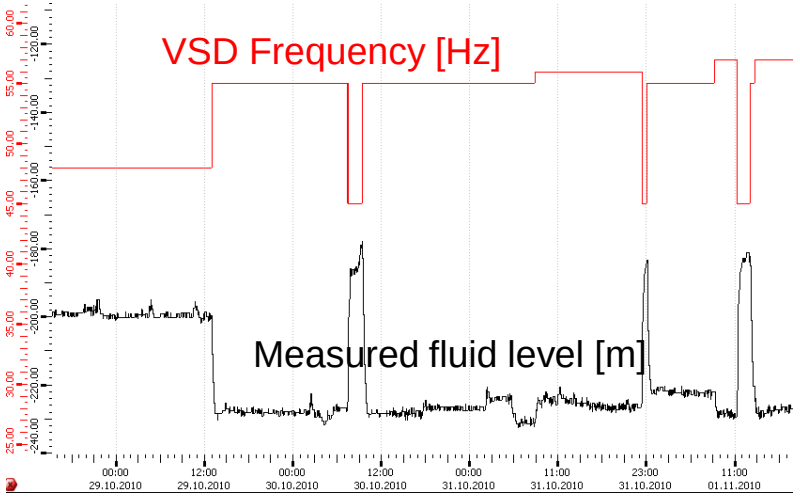
Measured fluid level



Fluid Level Measurement, Production Optimisation

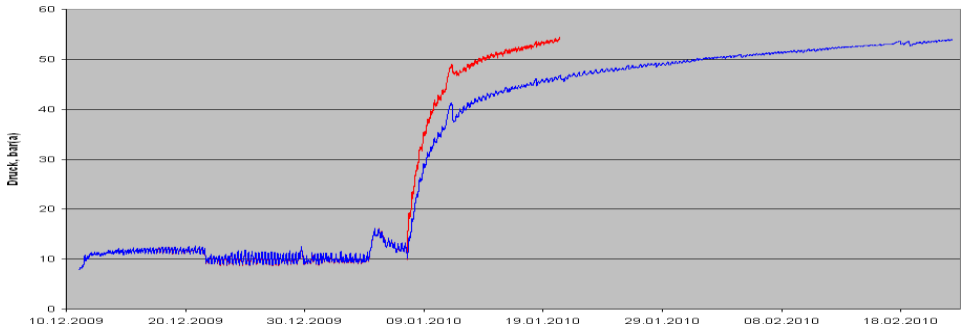
- Prevents pumps from running dry –> increases run life
- Pumps operated safely with maximum possible draw-down
- Accelerated production
- Increased ultimate recovery

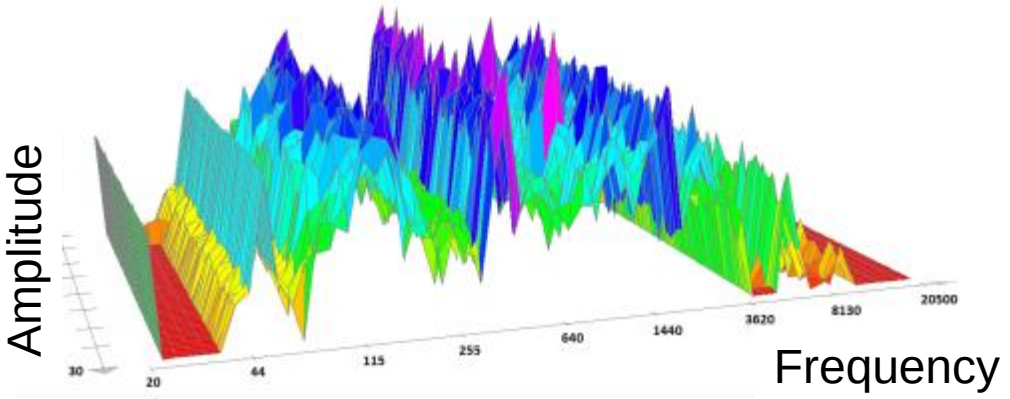
Response on change of ESP speed



Further Applications

- Reservoir Engineering
  - Pressure build-up survey
- Production Operations
  - Condition monitoring of downhole equipment using noise pattern
  - Detection of abnormal conditions with frequency analysis (valve malfunction, tubing leak, rod buckling, etc.)





Electronically Controlled Rod Rotator

- Measures load and assures rod rotation when side wall force due to buckling is minimum
- Rotates only when necessary, thus minimizing number of rotations
- Thus reduces wear on tubing and rods

INTELLIGENT MATERIAL SELECTION

Corrosion Inhibitor Selection & Implementation

Problem

- Corrosion, high water-cut with CO_2 in production operations

Field Data

- Produced media
- Materials in use
- Flow conditions

Candidate Selection

- Input field data
- 3-4 Products by service companies
- Pricing and dosage

Screening Testing

- Verify performance with lab tests (up to 10 test runs)

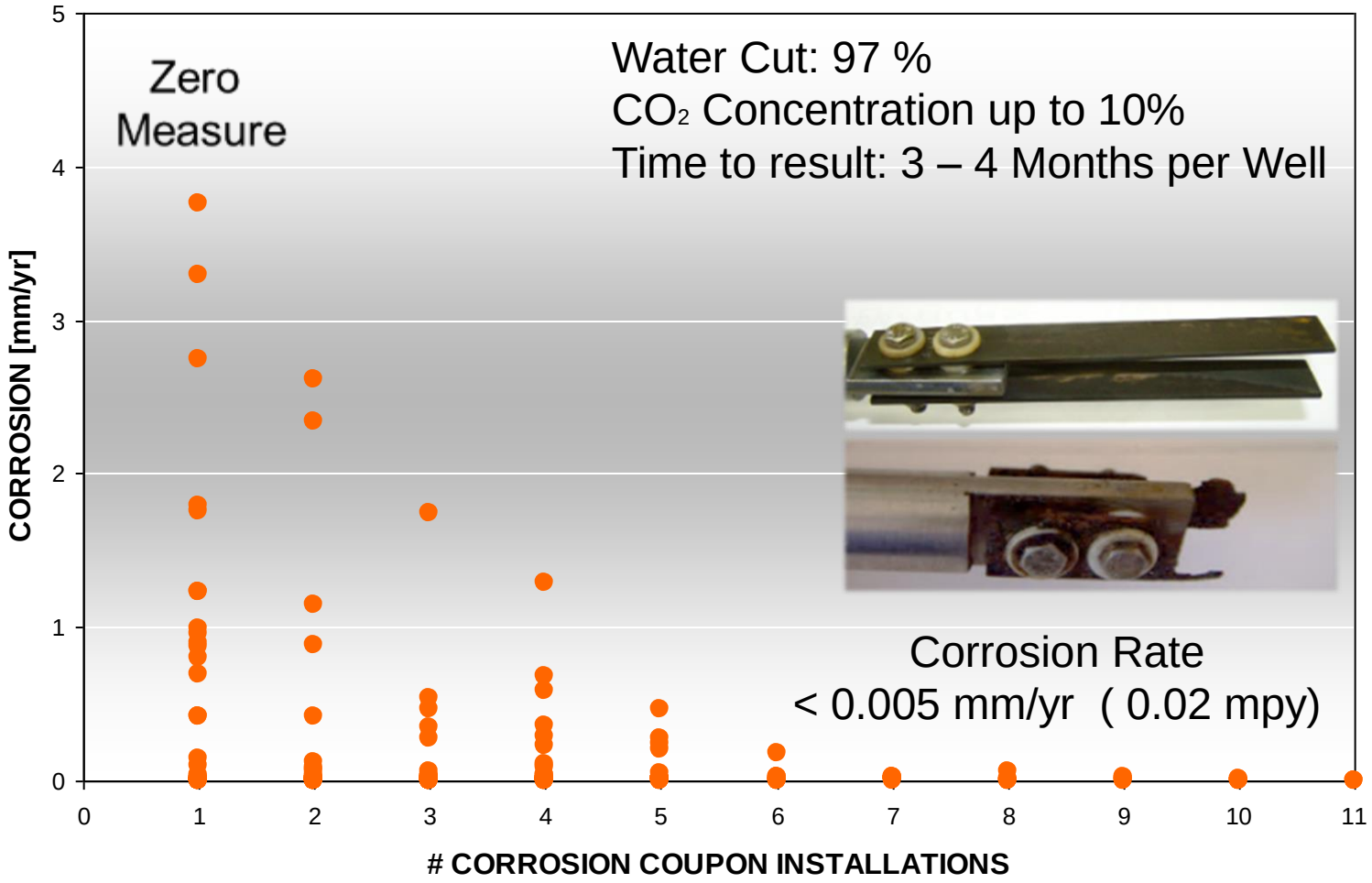
Final Testing

- Field test in actual environment

Final selection

- Based on commercial and operational results, product, cost, dosage

Corrosion Rate Survey Results (Field)



Erosion Control with Ceramic Sandscreens

- Unique material properties of SiC
  - Utmost resistance against erosion
  - Highly corrosion resistance
  - Lower density compared with steel (less weight)
  - Heat resistant up to 1800°C
  - High hardness
  - High stiffness

Stack of ceramic rings

Sand Screen for a North Sea Gas Producer

- The well was closed in since 1997 due to significant sand production
- Sand screen landed in nipple below production packer
- Set on production on February 2011, flowing well head pressure of 850 psi, gas rate of 6 MM scf/d, sand free, still producing with 2 MM scf/d with lower flowing pressure than ever

Reduction of Wear with Coated Sinker Bars

- Sinker Bars weigh the lower part of the rod string directly above the pump (more tension during „down stroke“) . Buckling and Friction is thus minimised.
- Specially designed „super fine surface finish“ metal film on flexible centralisers, which further smoothens surface and reduces the loss of material
- The metal film is also used for couplings of the rod string.

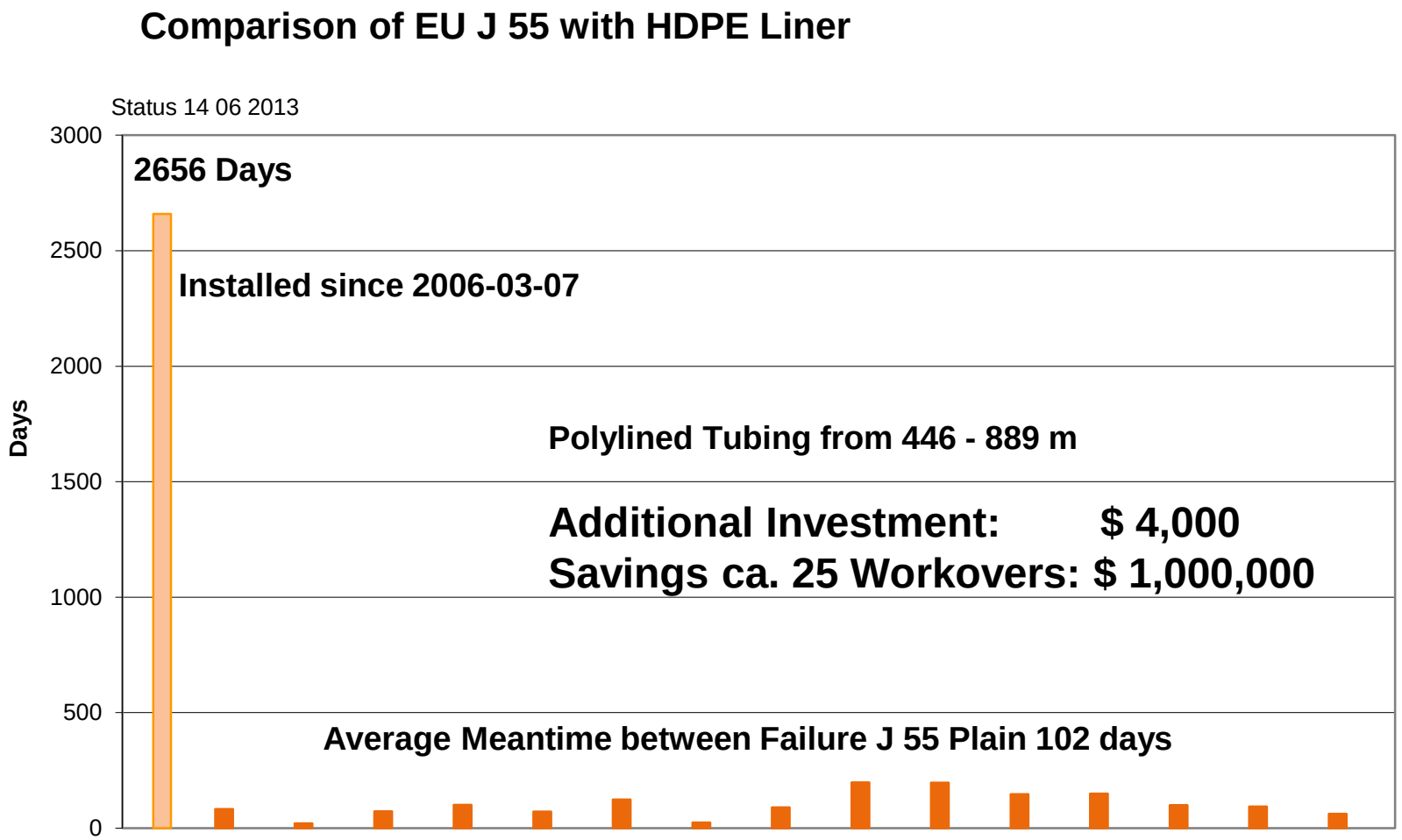
Sinker Bars with Super Fine Finish Coating

Reduction of Wear with Specially Developed Polylined Tubing

Modified HDPE – Temperature up to 95° C

- Advantages:
  - Less paraffin precipitation due to better heat insulation
  - Less tendency for depositions due to smooth surface
  - Less abrasion due to less friction
  - Energy savings due to less friction (10 to 15%)
  - Re-use of used tubing

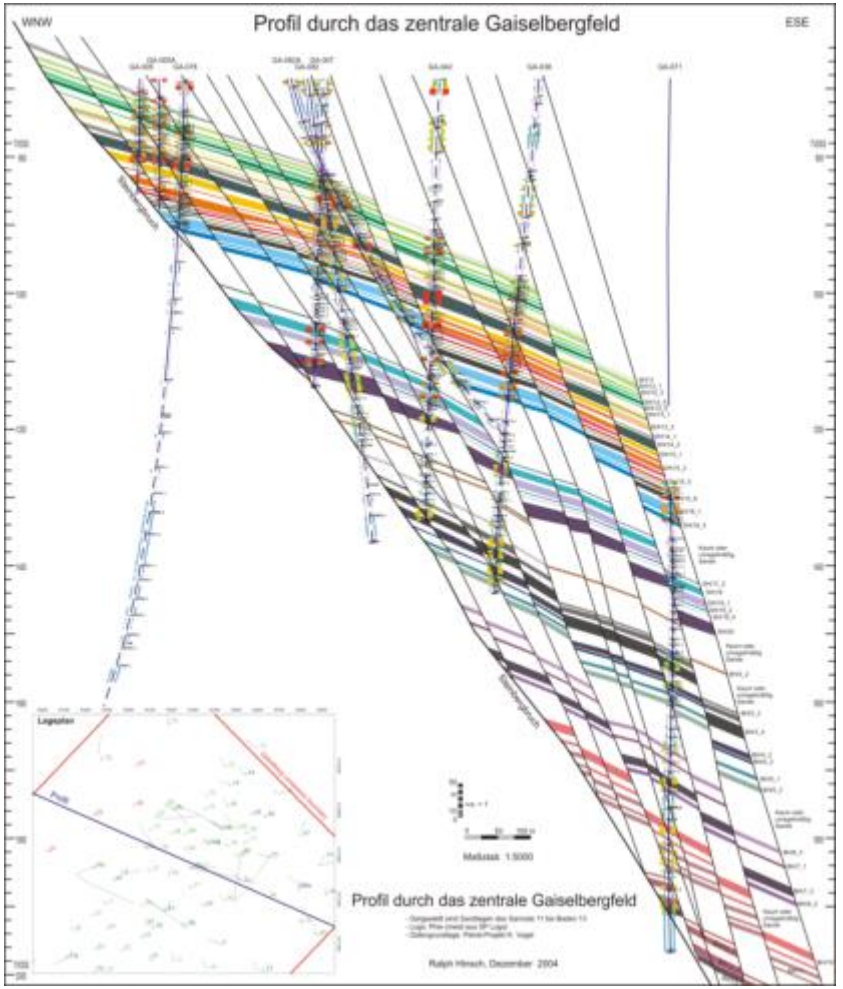
Poly-Lined Tubing



ECONOMIC EVALUATION

Case Study: Operation Centre Zistersdorf

- Two fields in Operation since 1937
- Complex Geology along the major „Steinberg“ Fault
  - Numerous small fractures
  - Many unconsolidated formations
- Hydrocarbon bearing more than 1000m in „Neogen“
- 62 wells (of which 30 in production)
- Up to 10% CO2 in associated gas
- High Water Cut (ca. 95%)



Significant Increase of Equipment Lifetime with a Reduction of Repair Workovers

- 2005

  190 failures

  per 100 active wells

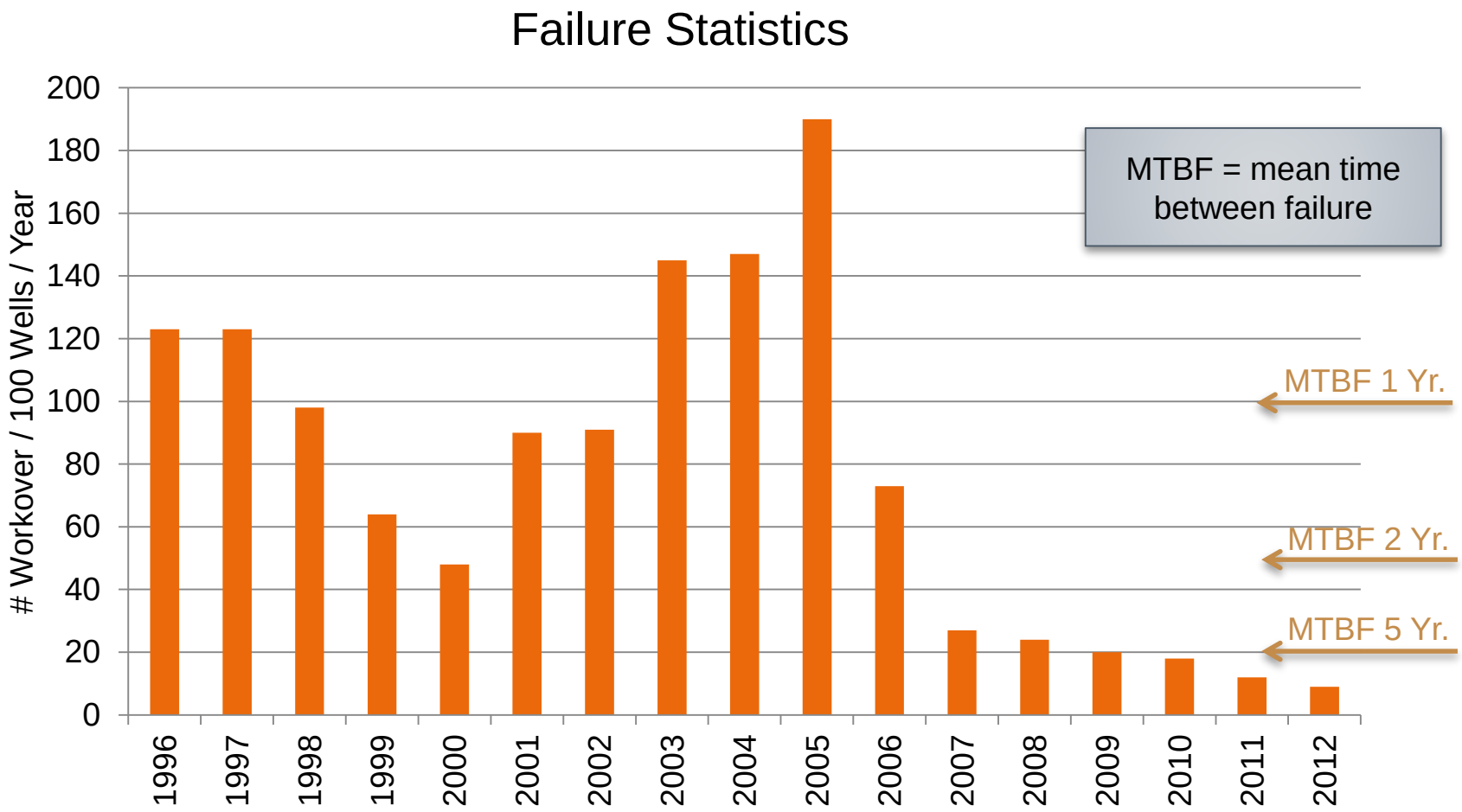
- 2012

  9 failures

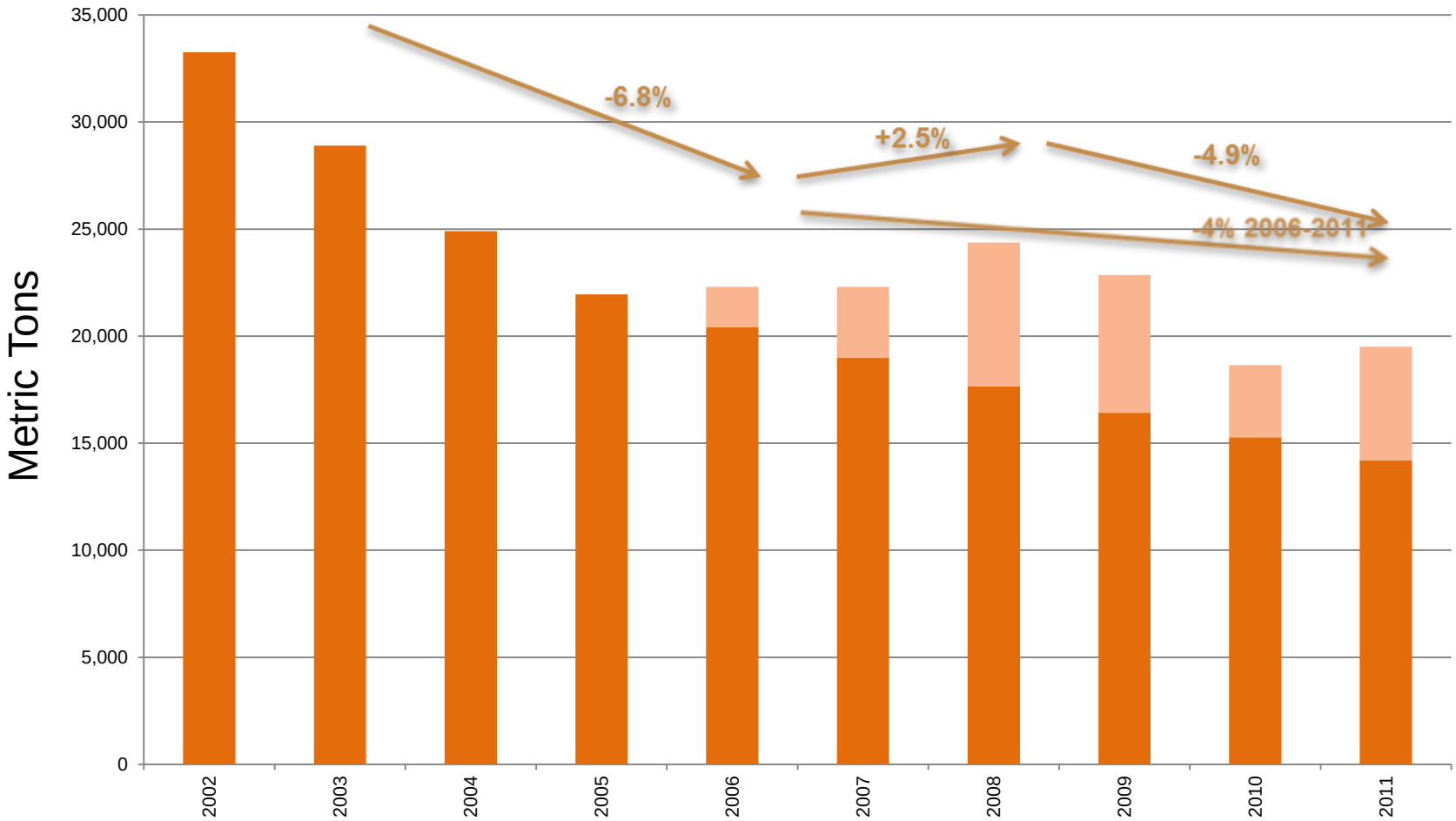
  per 100 active wells

Theoretical time between failures 11.1 years

Significant Increase of Equipment Lifetime with a Reduction of Repair Workovers



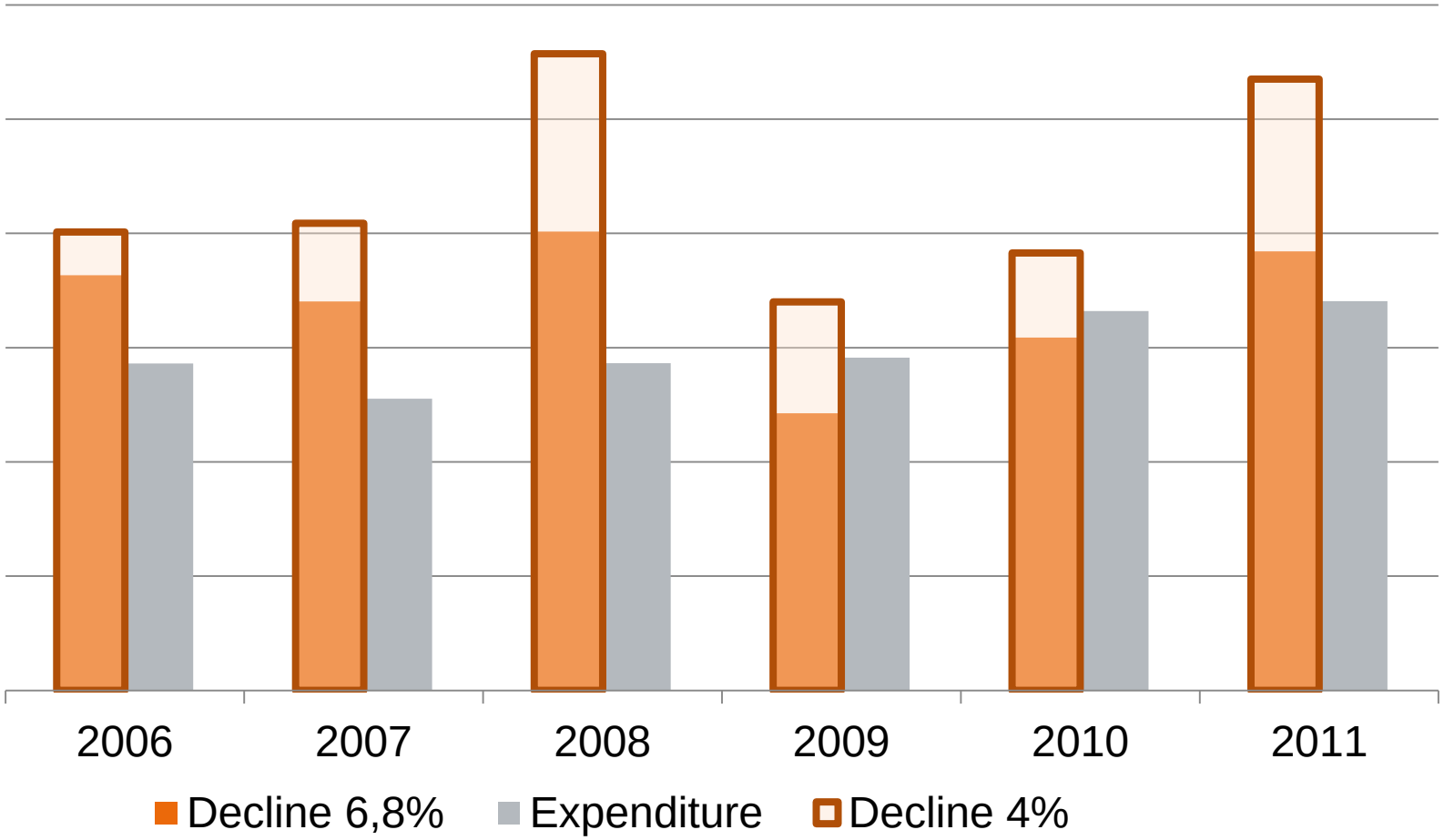
Production Results until 2011



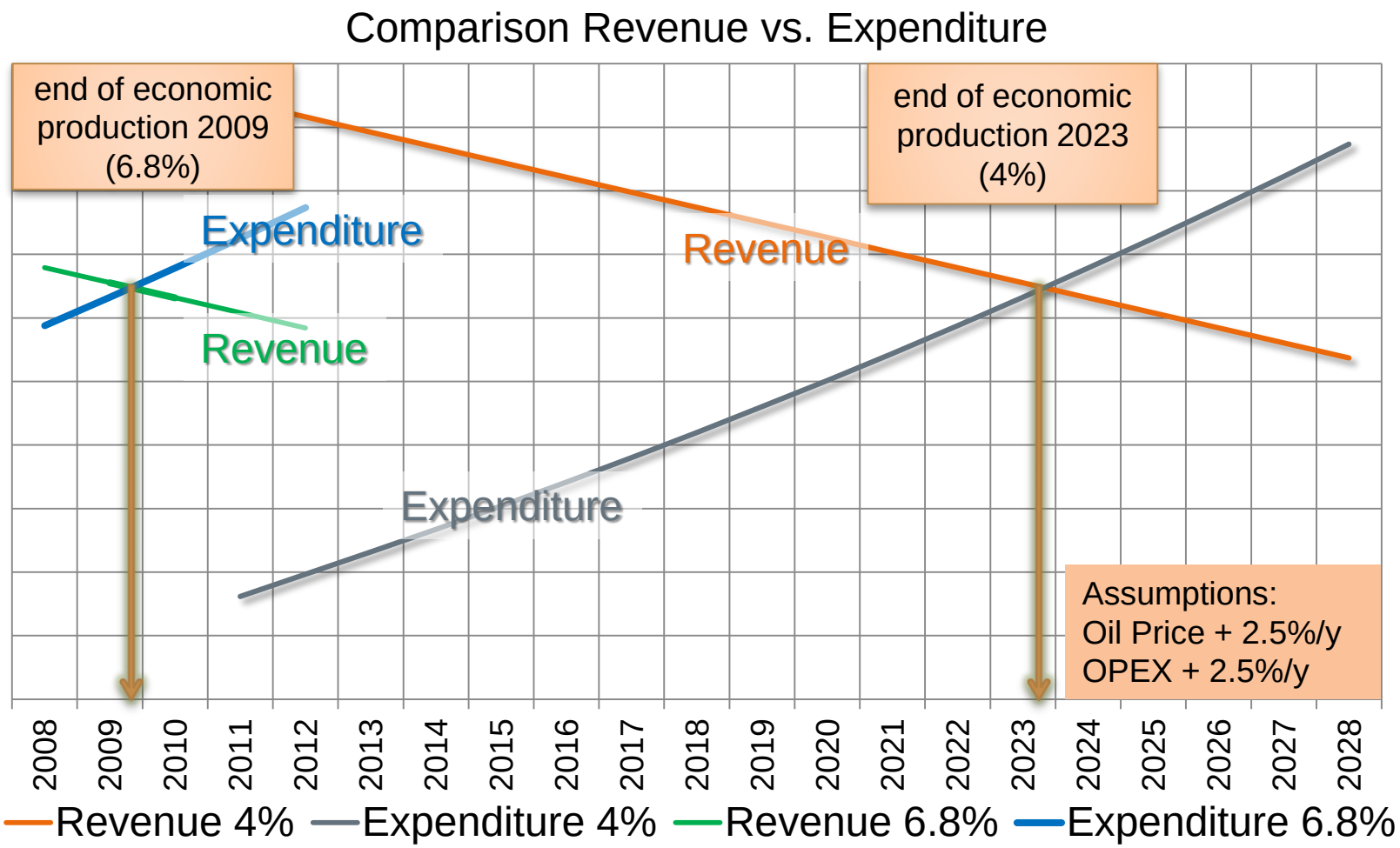
Production Forecast

- Case 1: Business as usual = Production decline 6,8%
- Case 2: Technology Implementation = Production decline 4%

Revenue vs. Expenditure 6.8% (base) vs 4%



Marginal Cost Analysis (6.8% versus 4% Decline



Conclusion: The Way to Success

- Challenge: Limited expectation of field lifetime
- Approach: Building a ‘Mature Field’ Competence Team to develop new solutions
- Process:
  - 1. Analysis of available technologies along the production chain
  - 2. Identification of advanced materials with exceptional lifetime in tough production environments
  - 3. Development of a stringent selection process for corrosion inhibition
- Results: Development of new technologies ‘fit for purpose’ , modifications of existing technologies, use of new materials.

The value of an idea lies in the using of it.

Thomas A. Edison

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