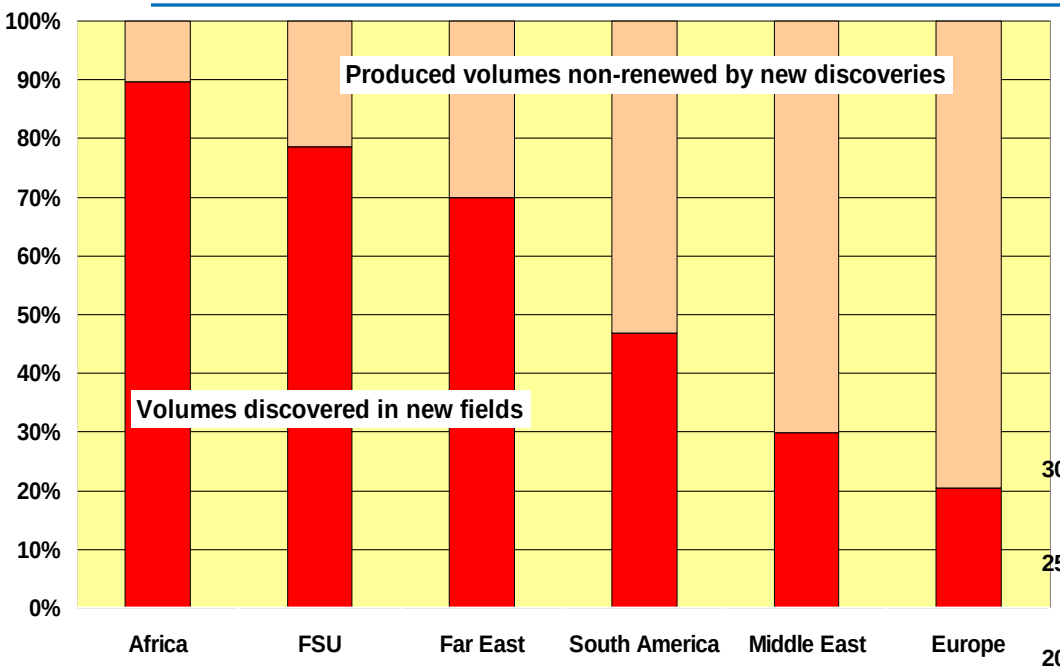
Pushing the limits

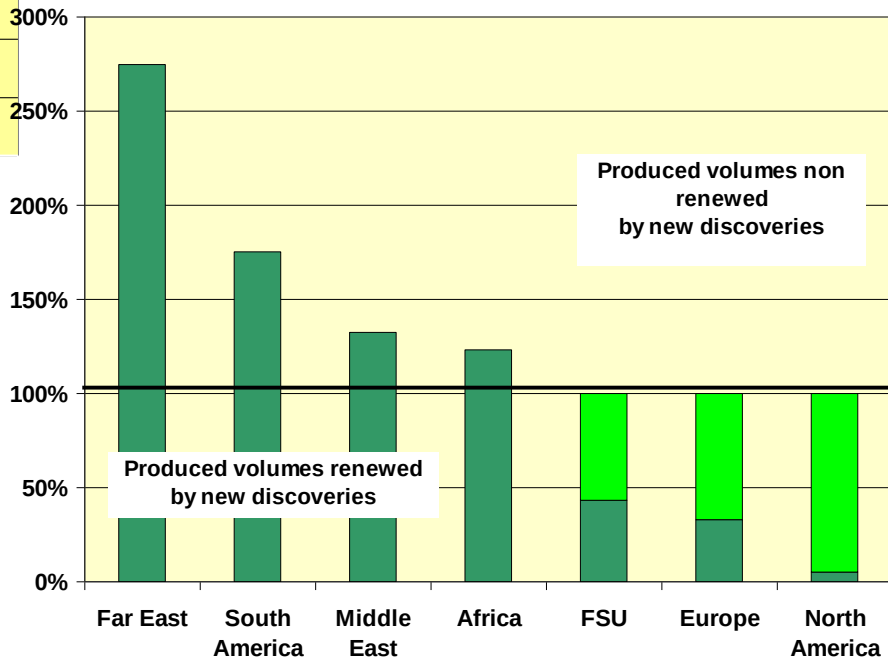
Impact of upstream technological advances on future oil supply

Reserves evolution



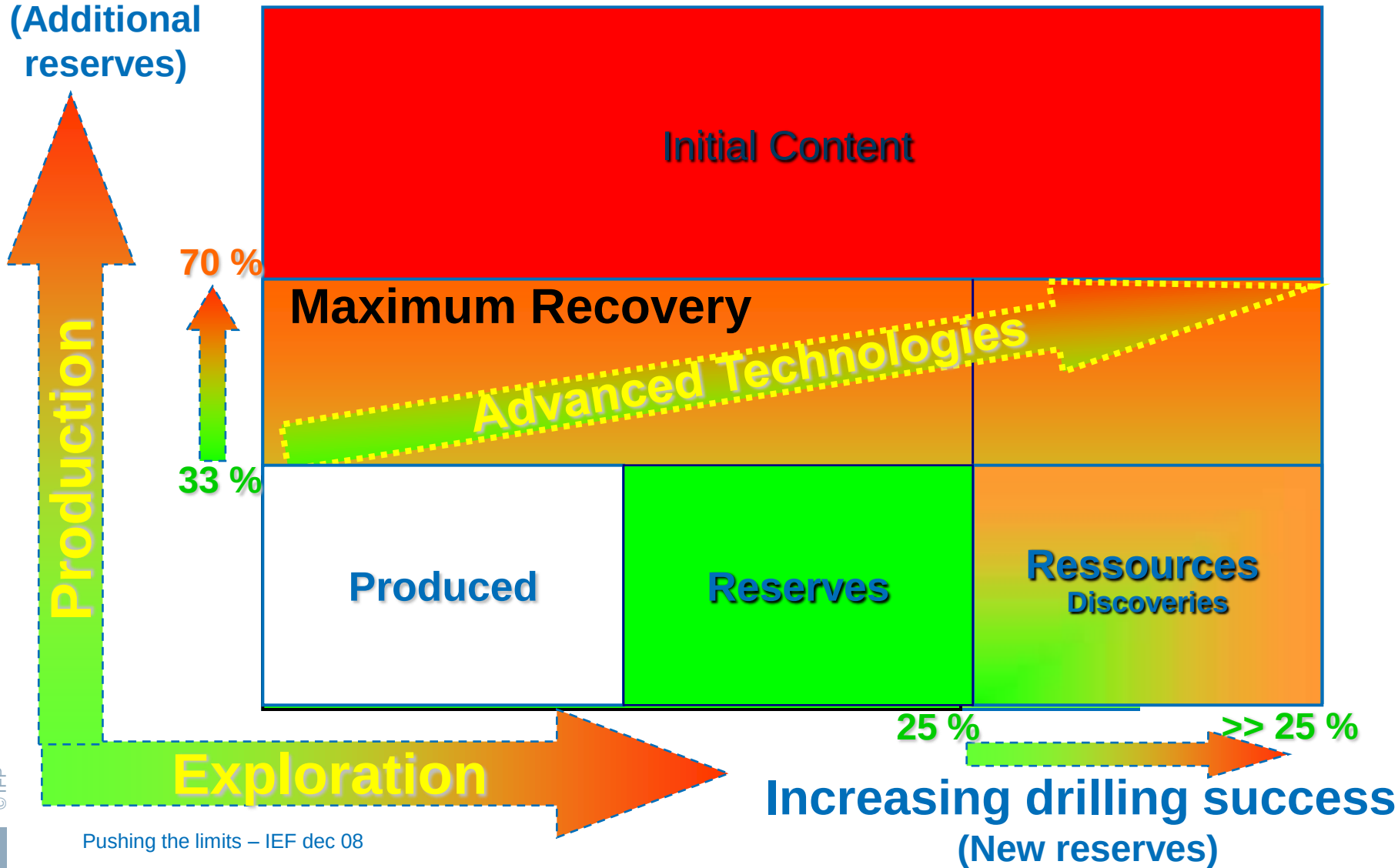
Oil

Gaz



Reserves evolution

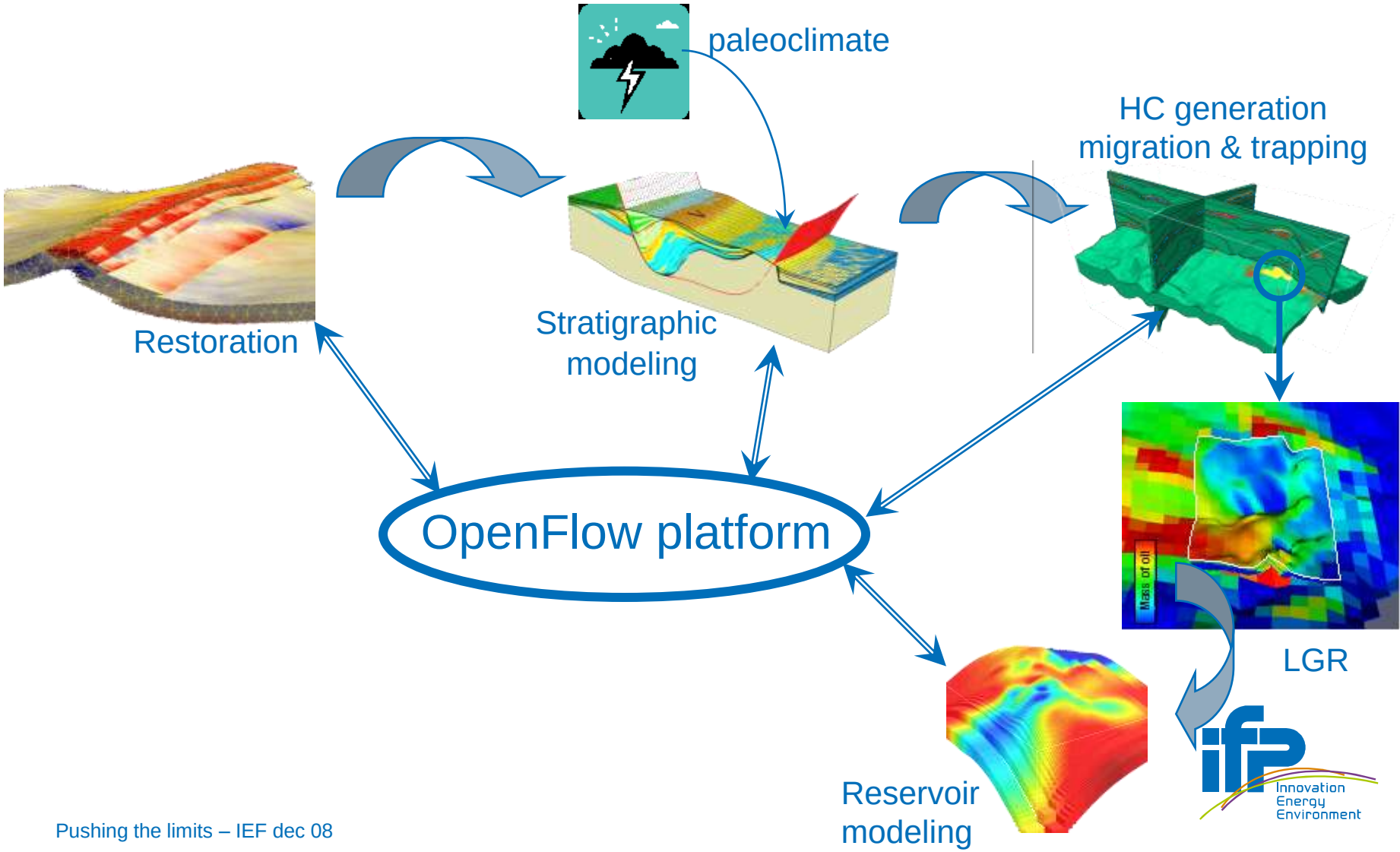
Source: IFP 2007



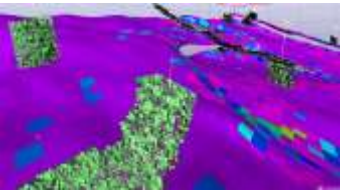
Exploration

- **Issues**
  - **reduce the risk in exploration**
  - **assess fluid composition and distribution**
- **R&D challenges**
  - **improve seismic imaging**
  - **improve the knowledge of geological processes**
    - **complex tectonics**
    - **sedimentary deposit**
  - **improve compositional modeling**
  - **include diagenesis**

Basin modelling towards full integration



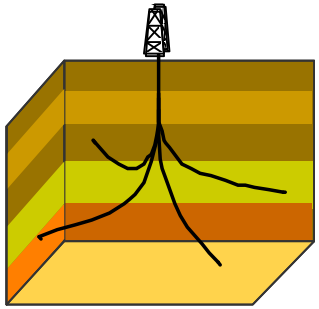
Renewing the reserves



Better locate the accumulations
Characterize the flow potential

Static & dynamic reservoir characterization

Reduction of uncertainties on OIP & reserves



Reservoir management

monitoring + interactive reservoir modeling

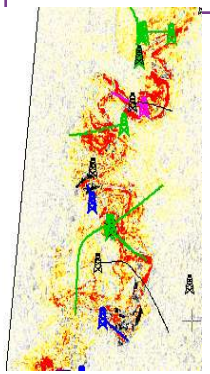
Redevelopment plans

Increase oil recovery

Optimize the production scheme to access OIP

Advanced well technology

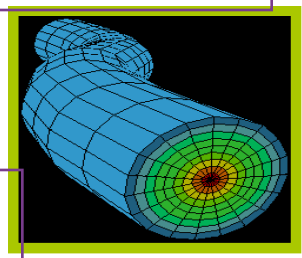
Additional reserves



Use of EOR processes

Thermal & chemical processes, Gas, CO2, N2, air injection

Increase recovery factor



Optimize well productivity

Formation damage control

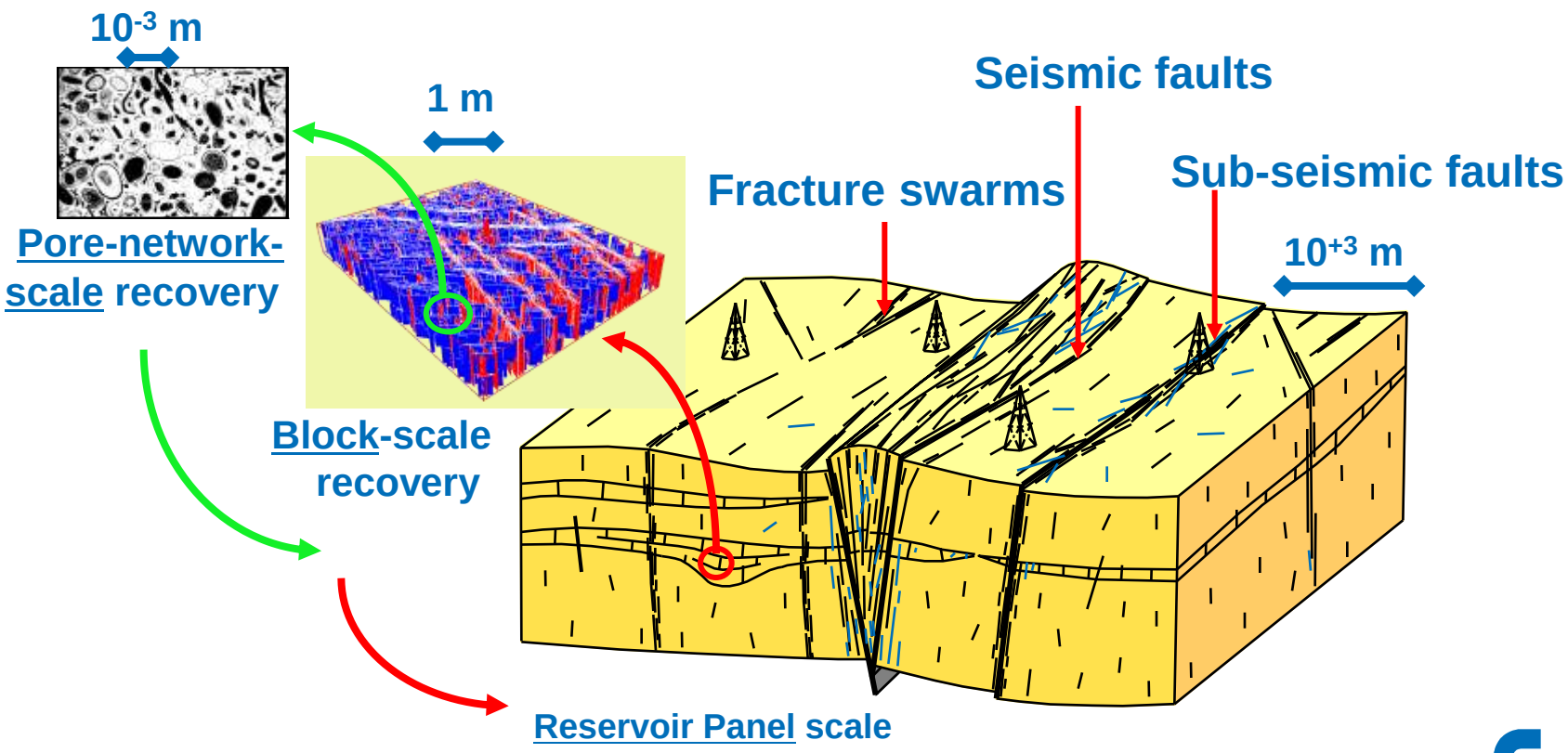
Completion strategy
Well profitability & Opex

Reservoir management

- **Issues**
  - **complex reservoirs**
    - **structure**
    - **heterogeneity**
    - **diagenesis**

- **R&D Challenges**
  - **characterize the geology and the flow path**
    - **at different scale**
    - **taking into account the heterogeneity (geostatistics)**
    - **quantifying its impact (sensitivity analysis)**
    - **quantifying uncertainties**
  - **include diagenesis**

Characterization



Reservoir management

- **Issues**
  - **improve the recovery factor**
    - **deal with complex fluids, complex recovery processes, heterogeneous reservoirs**
    - **assess and reduce the risk and uncertainties**
  - **get the best from specialized simulators**
    - **open structure**
    - **interoperability**
- **R&D Challenges**
  - **improve the physical modeling**
    - **thermodynamics, flow processes in porous media, pore network modeling, upscaling**
  - **improve the reservoir modeling workflow**
    - **taking advantage of interoperability to use the best technologies**
    - **updating the geological modelling using dynamic data**
  - **couple basin to reservoir, surface to subsurface**

Reservoir management

- **Issues**
  - **Increase production through EOR**
  - **produce reservoirs in a sustainable way**
- **R&D Challenges**
  - **carbonates**
  - **heavy oils**
  - **develop strategies that comply with environmental constraints**
    - **CO2 EOR/EGR**
    - **PWRI even with EOR**

Optimize the production

hybrid pipe

Clip™ riser

Production in deep offshore and/or remote reserves

CO2 transport & re-injection

EOR

Separation water re-injection

Gas Treatment

Transport from subsea to beach

Production

- **Issues**
  - **extreme environment**
    - **deep water**
    - **deeply burried reservoirs (DBR)**
    - **arctic**
    - **sour gas**
- **R&D challenges**
  - **improve facilities**
    - **material**
      - thermal insulation
      - weight (hybrid pipes, special metals, composites)
  - **improve flow assurance**
    - **hydrate transport**
    - **multiphase pumping**
    - **modelling opened platforms**
  - **handle sour gas**
    - **energy efficient solvents**
    - **improved contactors**
    - **cryogenic process**

Conclusions : technological advances contribution

- **Reduce the risk in exploration**
  - **seismic imaging (fractures, subsalt, foothills, ...)**
  - **basin modelling chain**
    - **from seismic data to fluid migration & trapping up to the reservoir model based on good physics, using advanced computer sciences**
- **Recover 70% of OIP**
  - **use advanced quantitative reservoir characterization**
    - **including diagenesis**
  - **develop efficient & sustainable EOR processes**
  - **optimize reservoir production**
    - **"real time monitoring" including production data & 4D seismic**

Conclusions : technological advances contribution

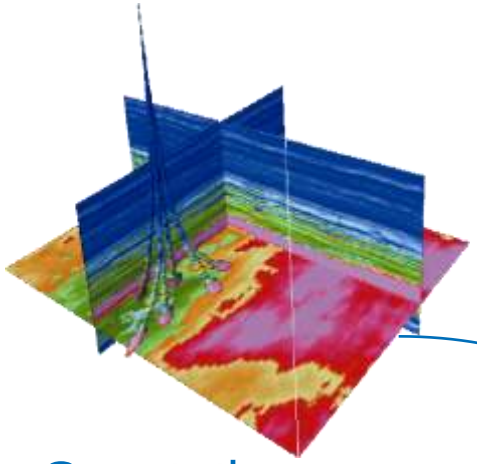
- **Produce under extreme conditions**
  - **subsea & deep water**
    - **reduce the weight of offshore facilities**
    - **optimize subsea separation**
    - **manage flow assurance (hydrates transportability)**
    - **real time monitoring/operation : couple reservoir & process modelling**
  - **sour gas**
    - **reduce the energy consumption**
  - **heavy oils**
    - **optimize through better reservoir characterization & monitoring**

Thank you !

Innovating for energy

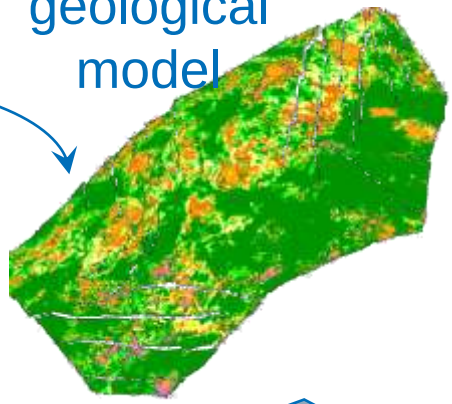
Innovation
Energy
Environment

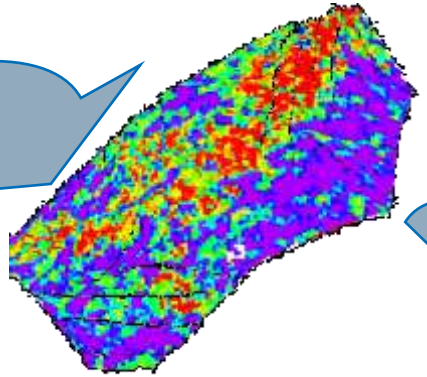
WorkFlow based on an Opened platform



Geostatics

geological model



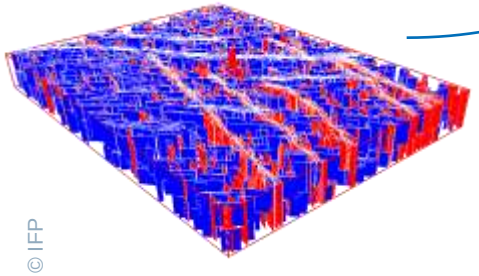


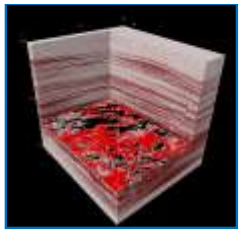
Upscaling

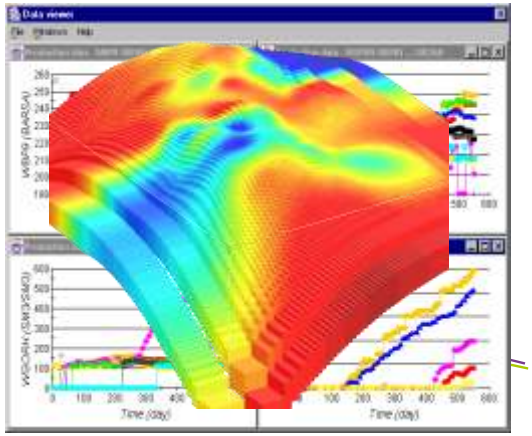
CondorFlow Loop

Dynamic simulation

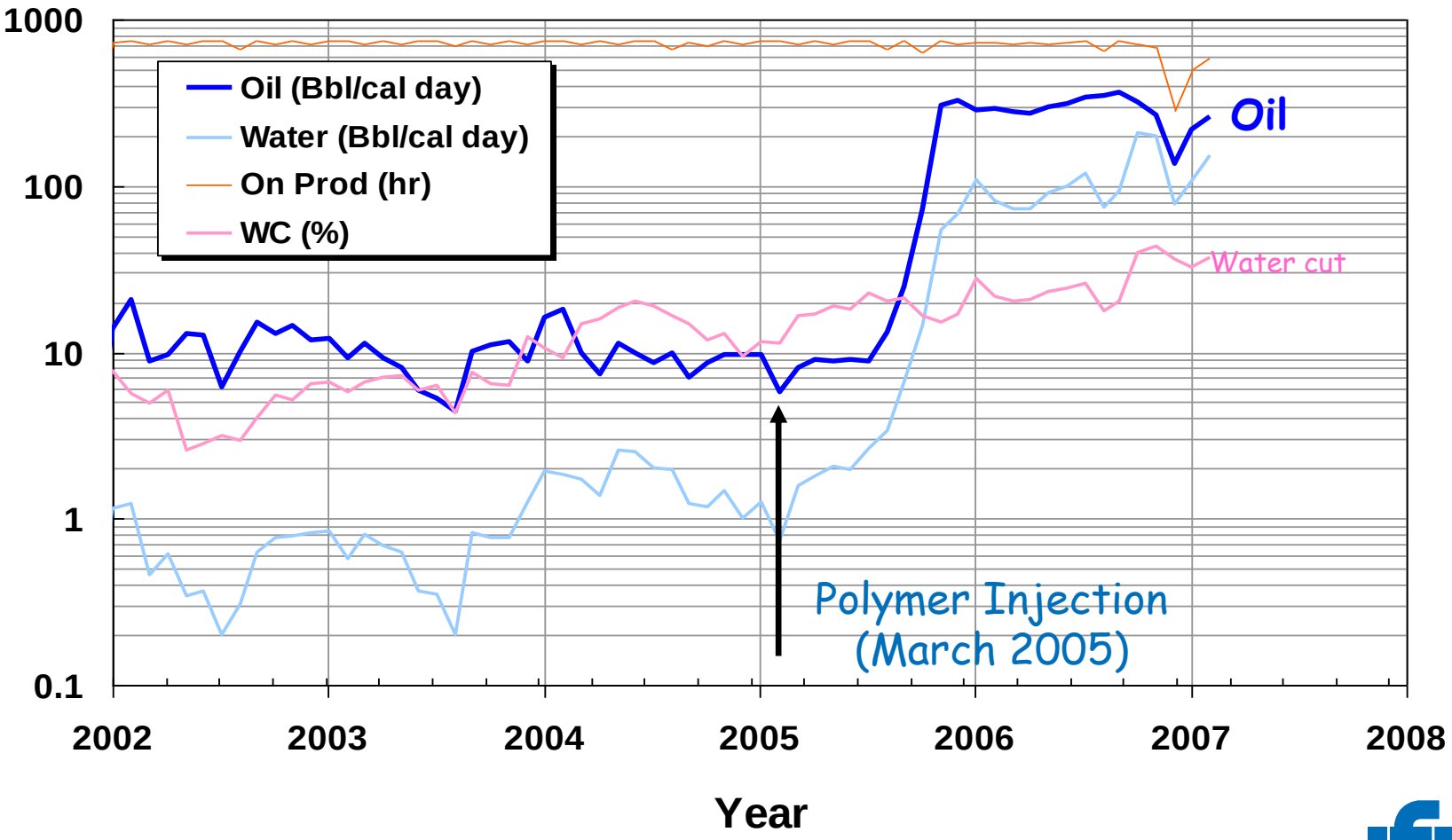
Fractured reservoirs





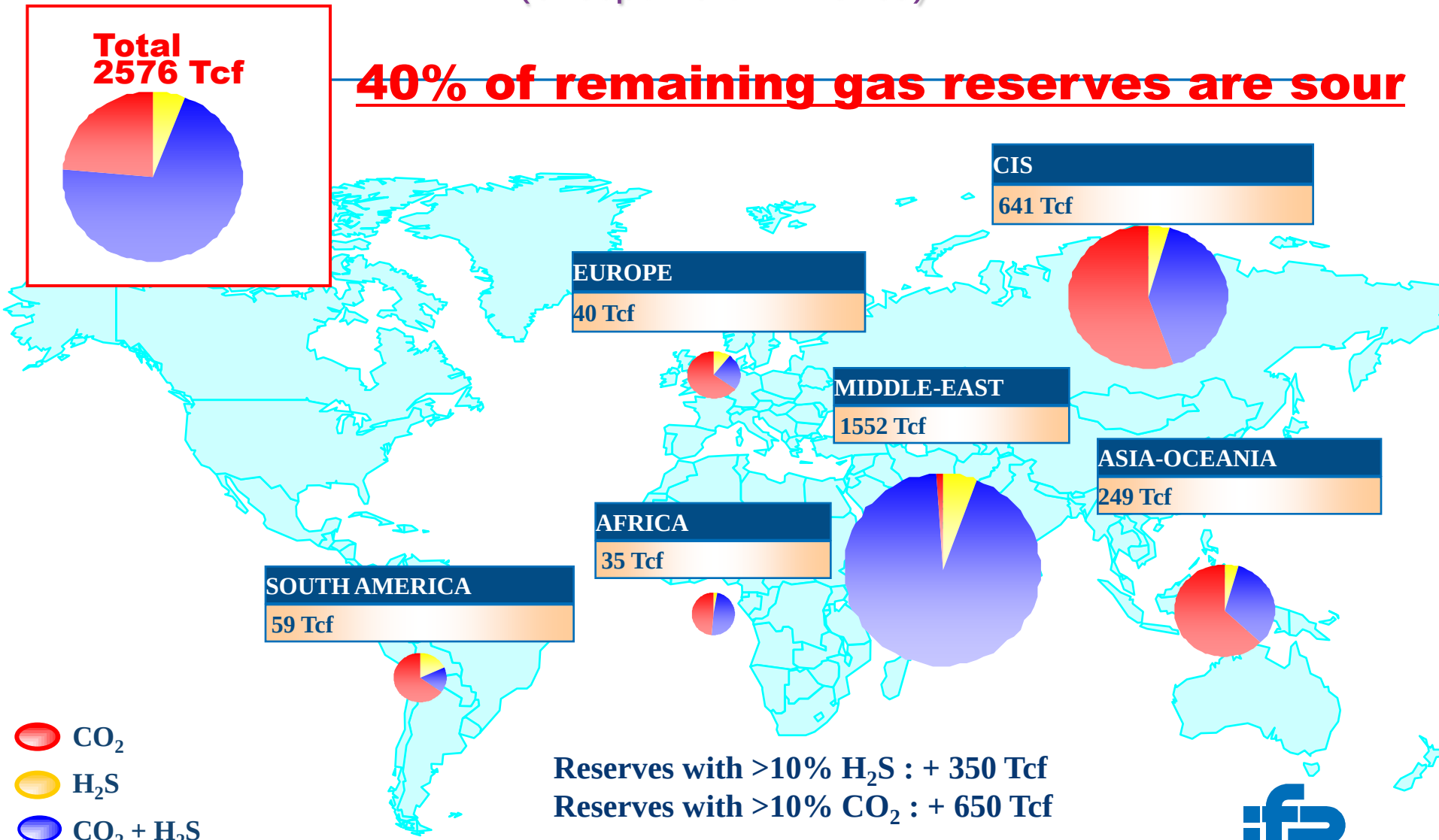


Polymer flood : Field Results



Successful pilot calls for more than 100 wells a year to be drilled between 2007 and 2010 with total expenditures > $800 million.

Acid gas reserves with CO_2>2% and/or H_2S>100ppm
(except North America)



Reserves with >10% H_2S : + 350 Tcf
Reserves with >10% CO_2 : + 650 Tcf

Source: Total - Iris 21 database from IHS Energy June 2004

Sprex®: Lacq pilot plant