

Risk assessment and impact on technology decisions

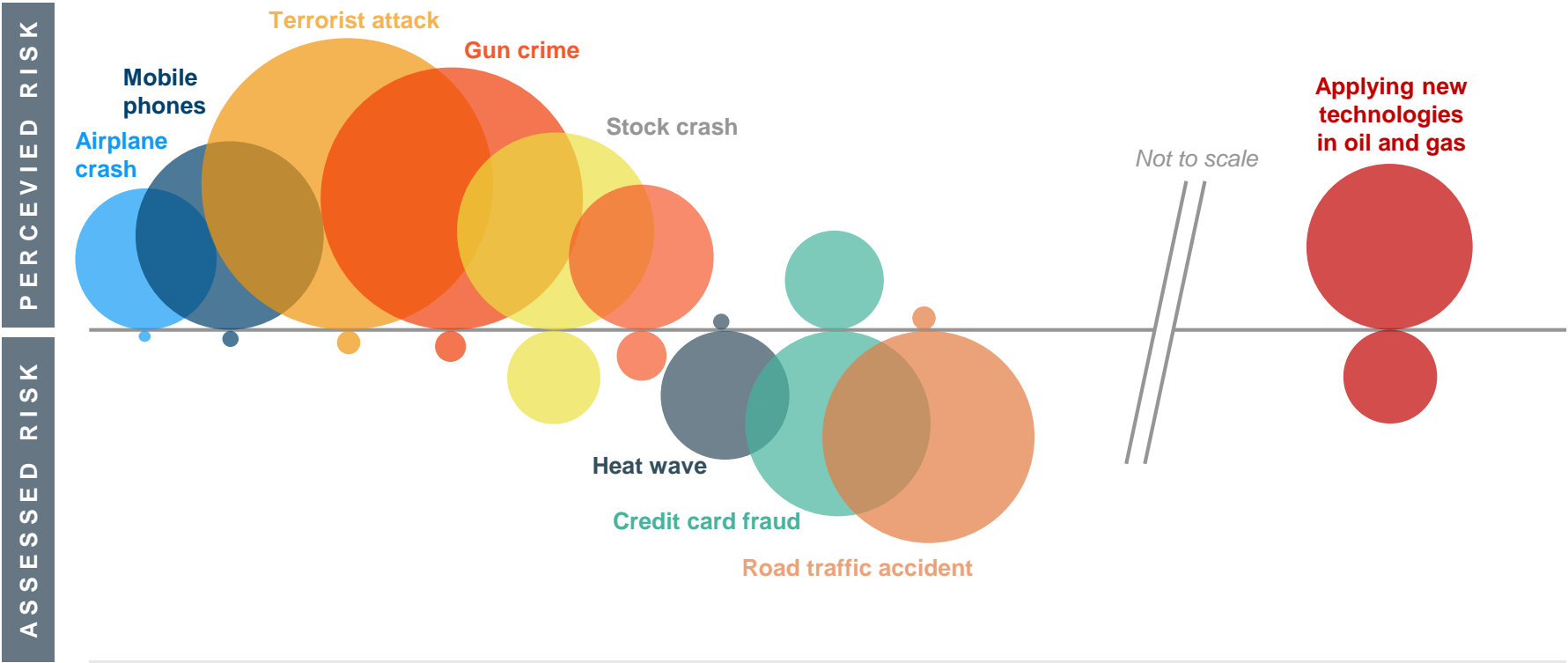


Miljødirektoratet
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Perceived risk seldom aligns with assessed risk – oil and gas technologies are no exception

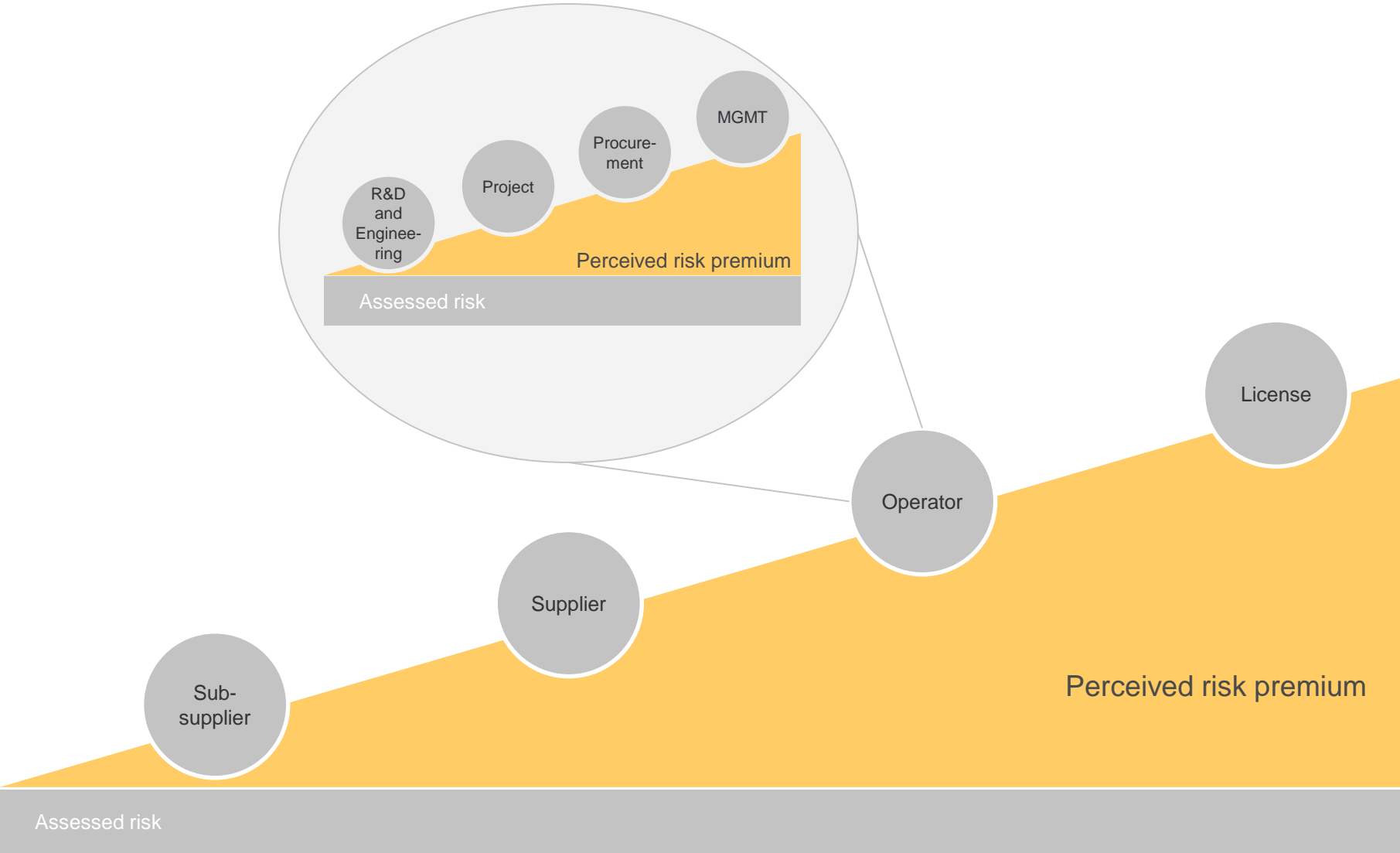
Risk perception vs assessed risk



- Studies reveal that there is a large discrepancy between the scenarios that the population fears and those that are actually harmful (see chart above). I.e., the public's perceived risk of flying is far higher than that of driving a car. Assessed risk of flying is actually very low, and driving a car is objectively one of the more dangerous things to undertake.
- In the OG21 strategy, **perceived risk is identified as one of the barriers of technology adoption**. That is, an additional premium on the assessed risk, explaining the conservatism and risk aversion that characterizes the industry in adopting new technologies.
- For the purpose of this study, we always assume that the perceived risk is higher than the assessed risk, driven by the detailed procedures on HSE and qualification underlying risk assessment procedures.

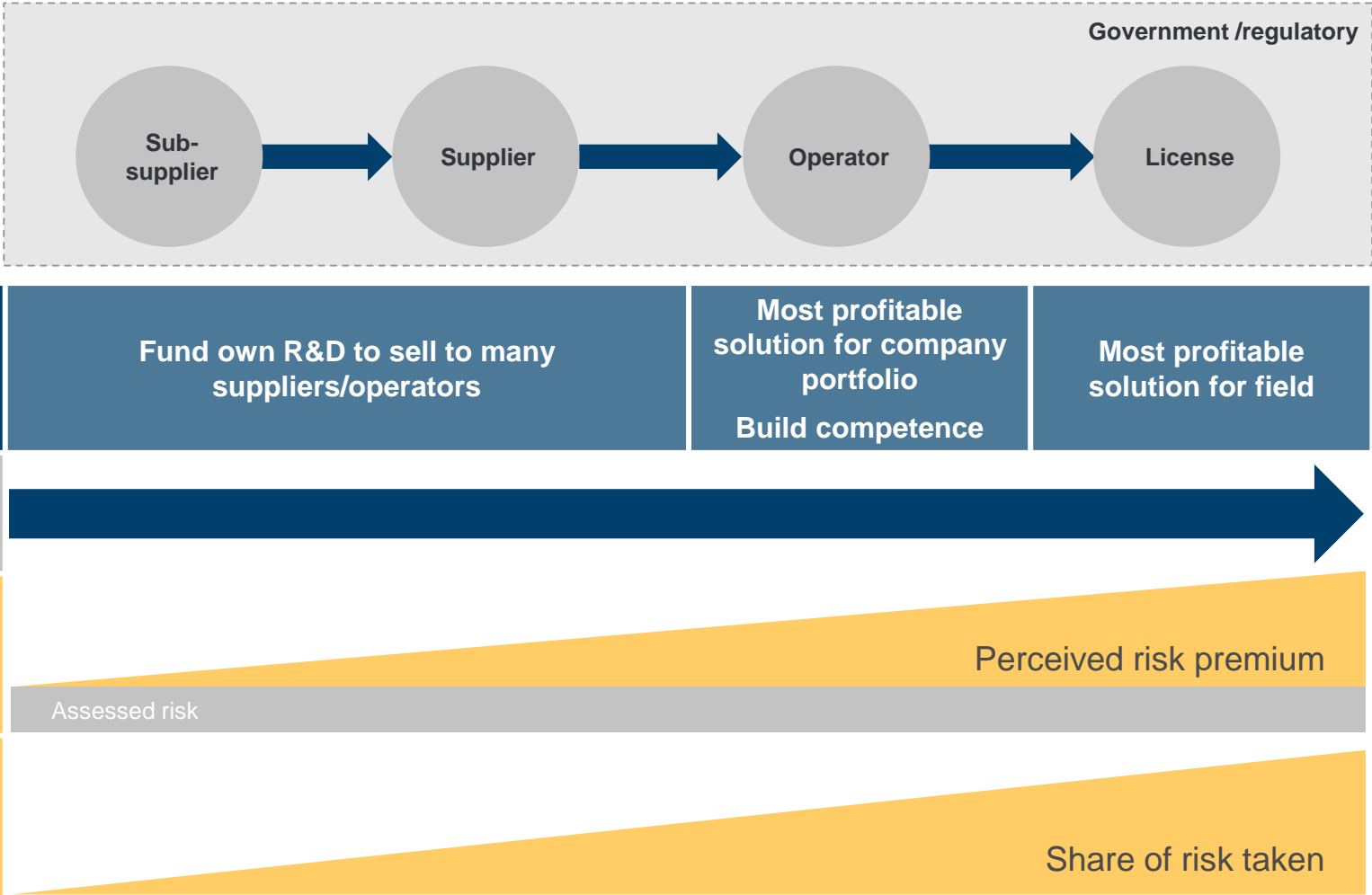
Source: Susanna Hertrich, 2008: «Reality Checking Device»; OG21 2016 strategy; Rystad Energy research and analysis

Distance from technology affects the perceived risk of the technology, also within the operator



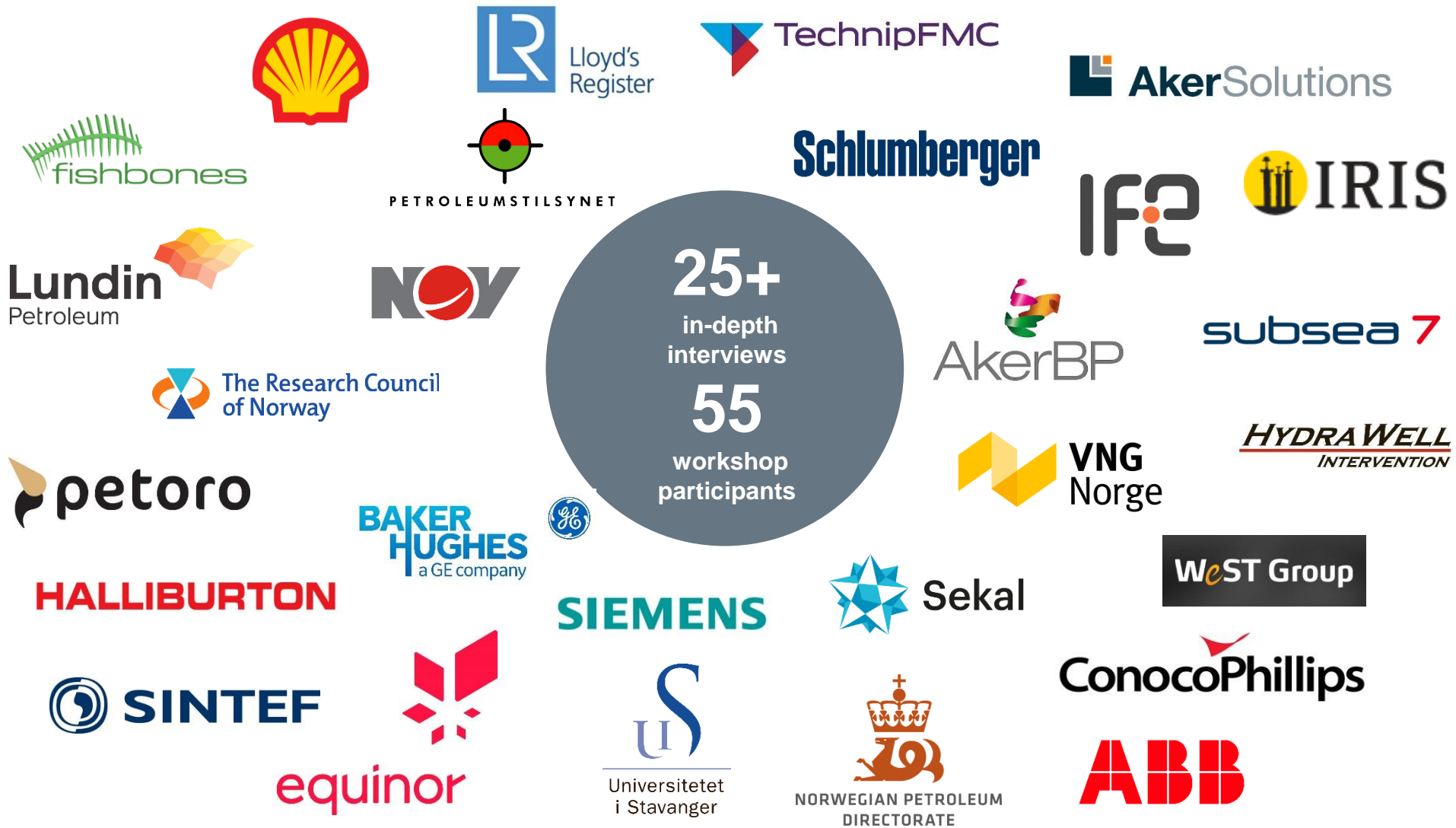
Source: Rystad Energy research and analysis

Perception of risk and value likely to be different in the various “decision locations”



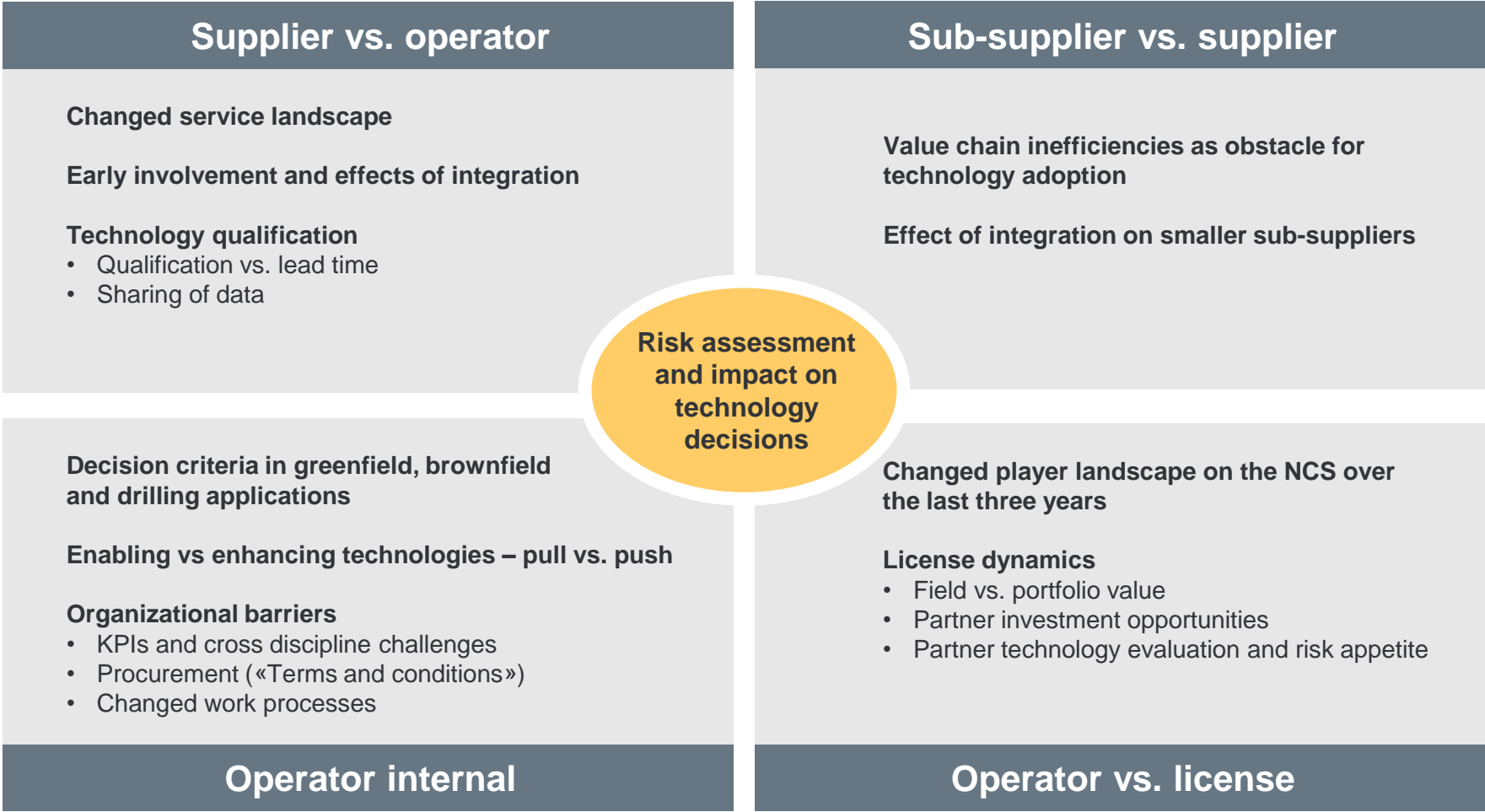
Source: Rystad Energy research and analysis

Stakeholders from a wide range of companies and institutions have provided input

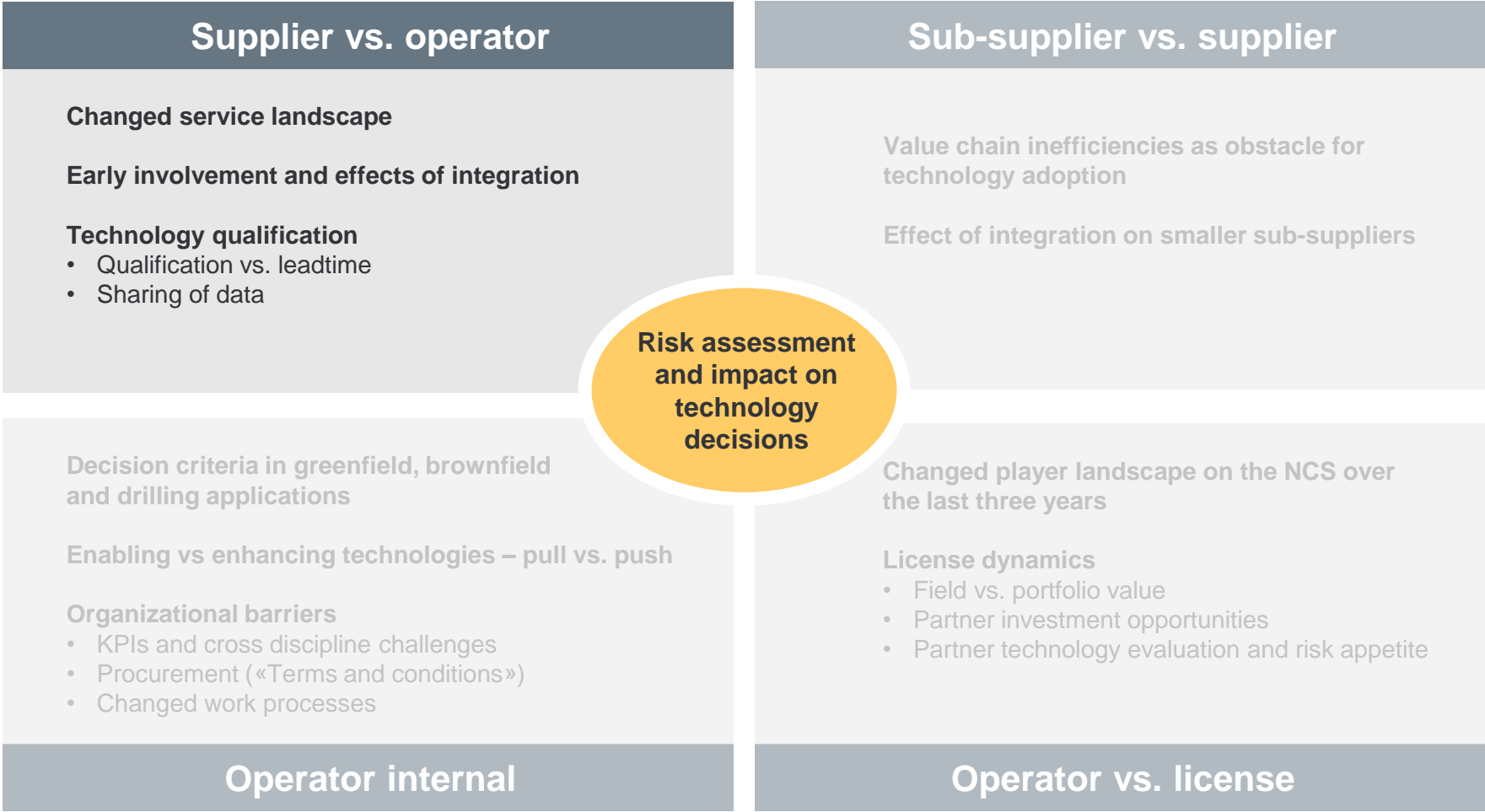


Source: OG21; Rystad Energy

Four perspectives on risk assessment and impact on technology decisions

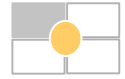


Source: Rystad Energy research and analysis

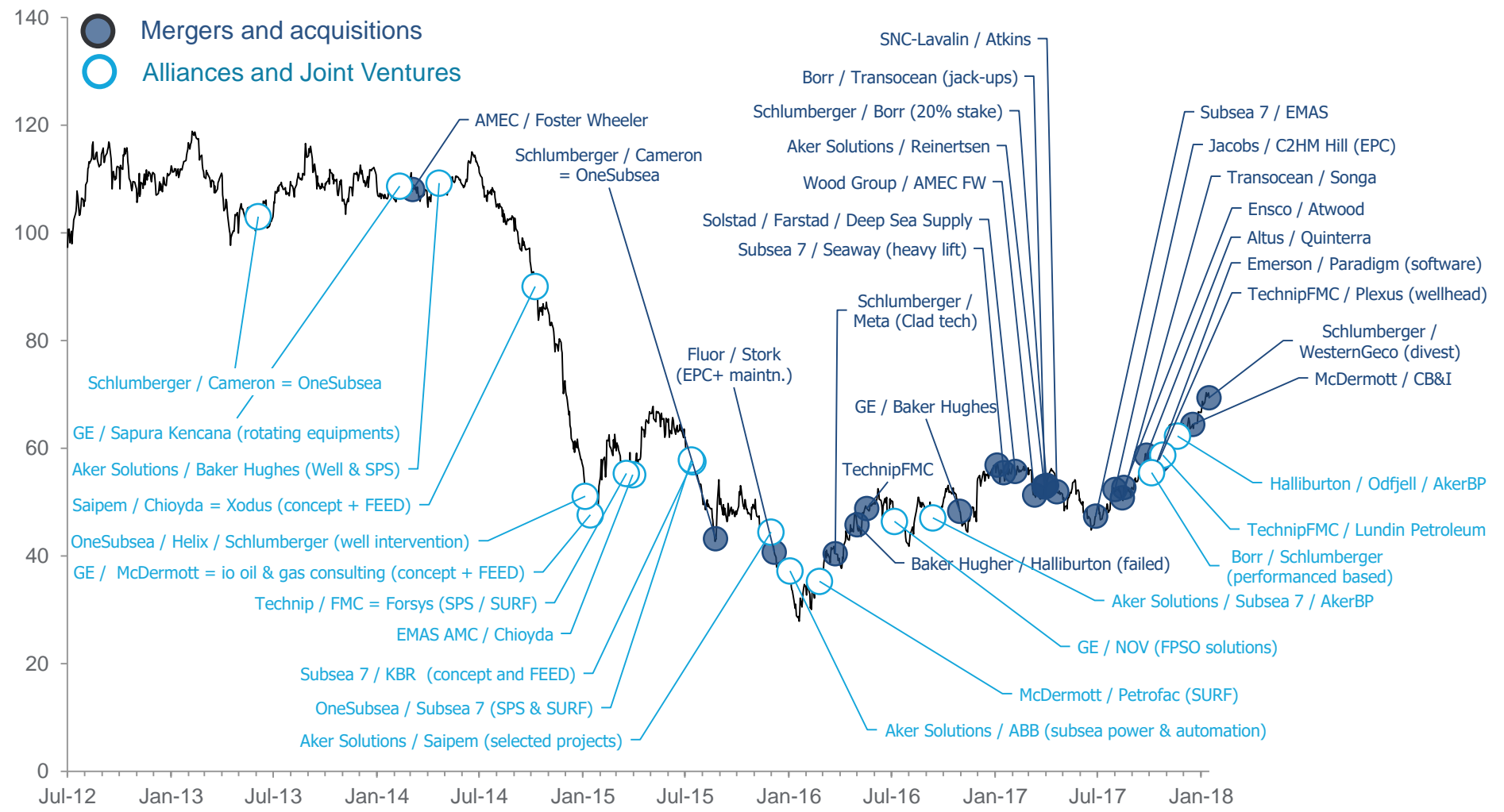


Source: Rystad Energy research and analysis

Alliances and JVs followed by M&A in the downturn



Alliance, joint venture and merger & acquisition in Offshore OFS, July 2012 - Jan 2018



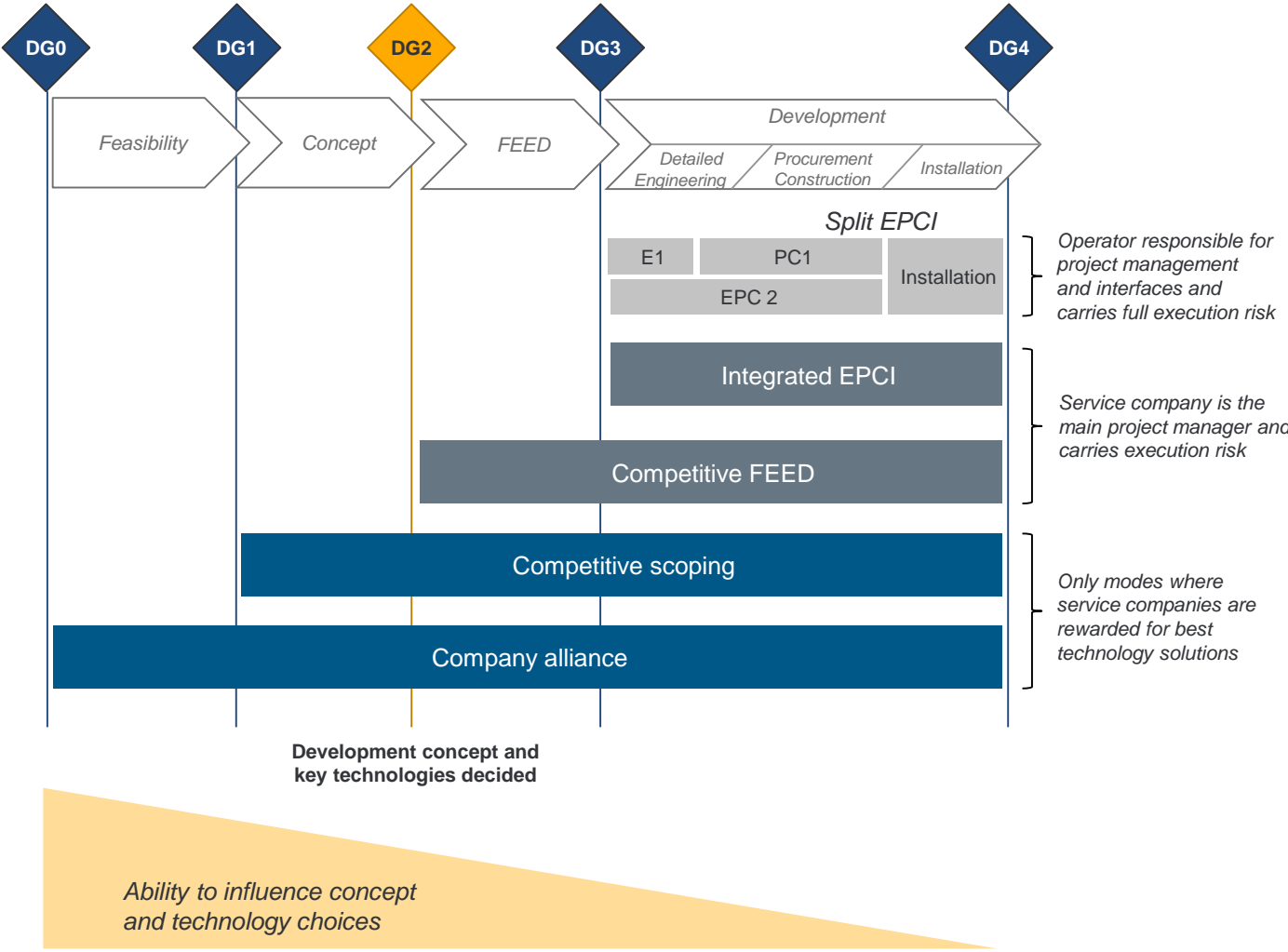
Source: Rystad Energy research and analysis





Integrated contract modes' effect on risk and technology decisions

Project development process and integrated contract modes



- **Contract modes have changed to more incentive-based structures to align supplier and operator interests.** Integration is not a prerequisite for shared incentives, and this can be detailed in conventional contract modes as well.
- A large part of the motivation from both suppliers and E&Ps has been to **share project execution risk and reward.** All the four integrated set-ups illustrated to the left accomplish this.
- The use of new technologies is typically decided at DG2. This means that the **only two contract modes that reward and incentivize oil service companies for innovative concepts are company alliances and competitive scoping.**
- Also, for **post DG2 contract modes**, it is the operator (or the engineering firm contracted) that is responsible for evaluating the portfolio of technologies that can form the development concept for a field. This **demands high technology competence inside the operator to successfully evaluate the full portfolio of opportunities.**
- **Similarly, early lock-in of suppliers** (i.e. through company alliances) **will limit the technology options to the suppliers' portfolio of products and services.**

Source: NPD; Interviews; Rystad Energy research and analysis

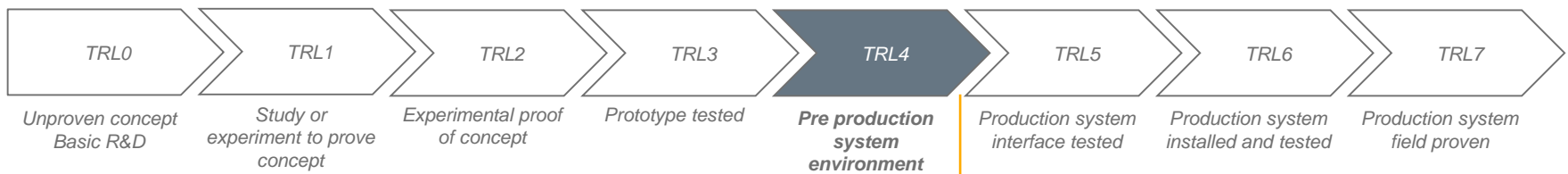


TRL4 stuck between two chairs, “too big for Rotvoll” and too time consuming for license to adopt

Maturing technologies

Technology Readiness Level (TRL) – API17N

Steps on the TRL ladder



E&P funding source



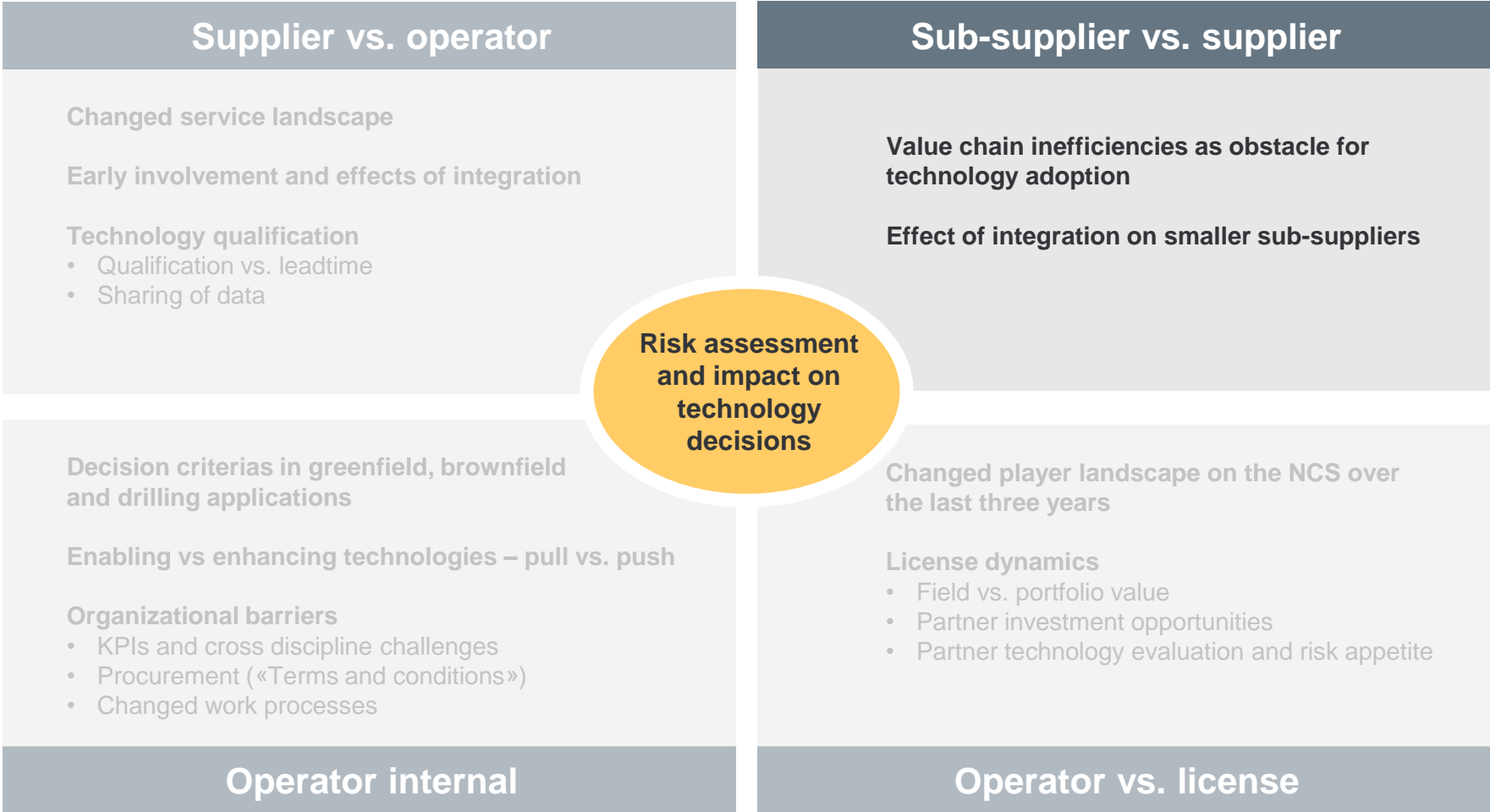
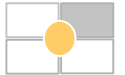
To qualify a technology from TRL3 to TRL4 is typically too expensive to be carried over the operators’ R&D budget and will need funding from a license

Paradox

All operators interviewed require a technology level of TRL4 or higher before sanctioning a project (DG3)*

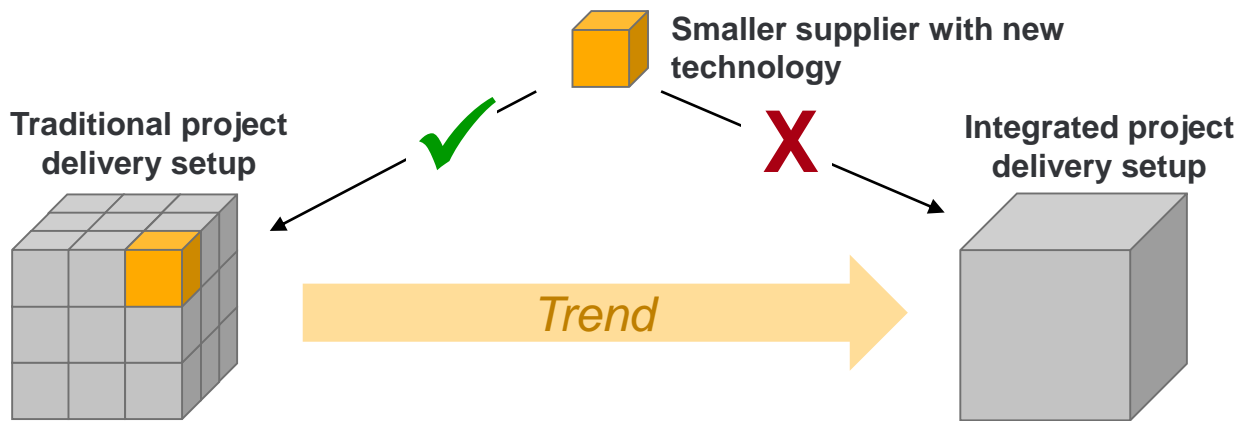
Paradox:
Technology qualification does not match time sensitive nature of the development project, yet is dependent on the project for further maturation

*Exceptions exist, but using less mature technologies increases risk of project delay significantly
Source: Interviews; OG21 2016 strategy; Rystad Energy research and analysis



Source: Rystad Energy research and analysis

Operators are playing with bigger building blocks; smaller suppliers can't deliver directly to operator and must go through the integrated service company



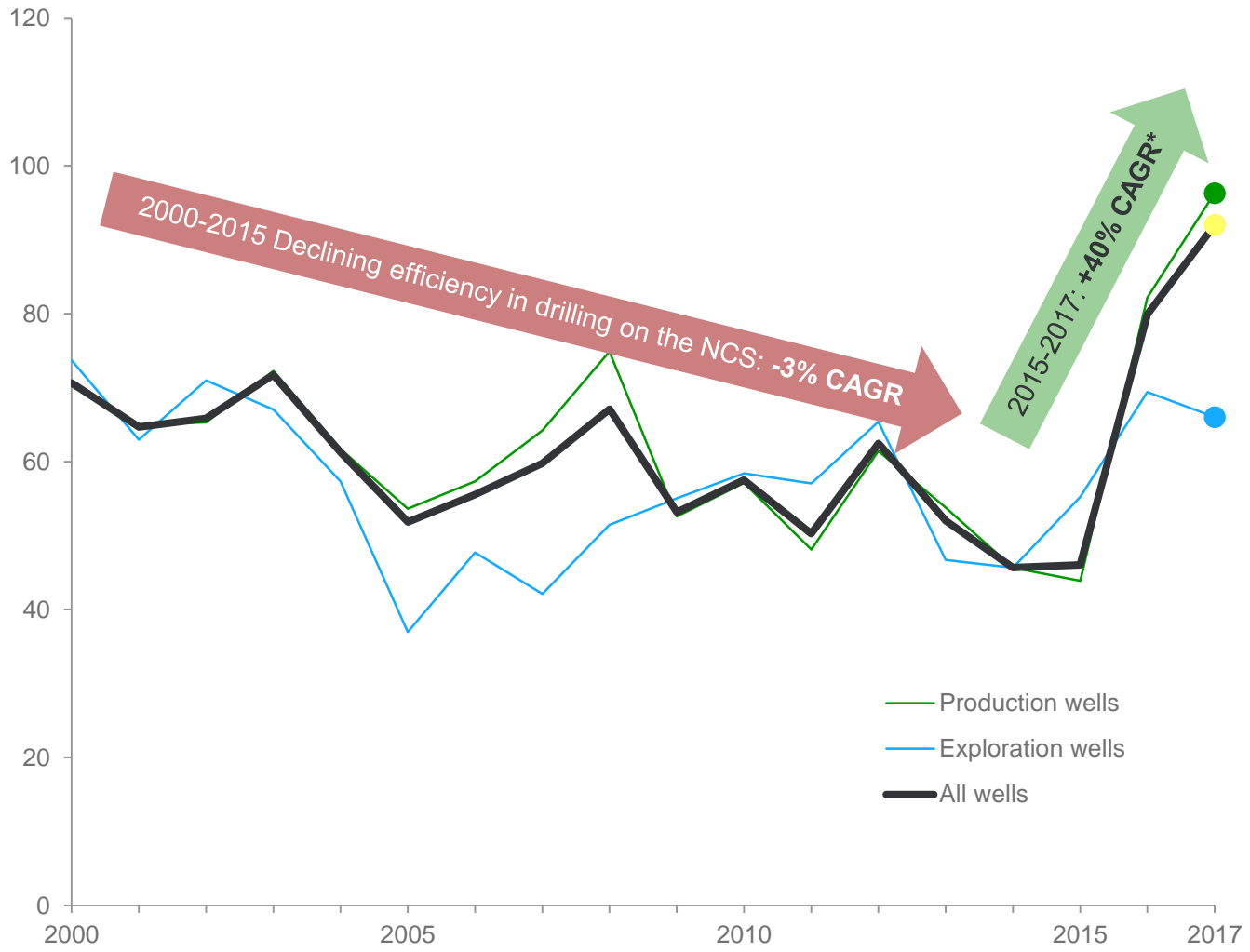
- Split contracts, smaller building blocks purchased at a time.
- Possible for smaller supplier with independent delivery to operator
- Integrated contracts, bigger building blocks
- Sub-supplier cannot deliver directly to operator

**New ventures have been key in developing technologies to keep the NCS competitive
Where do they fit now? Who takes the risk?**



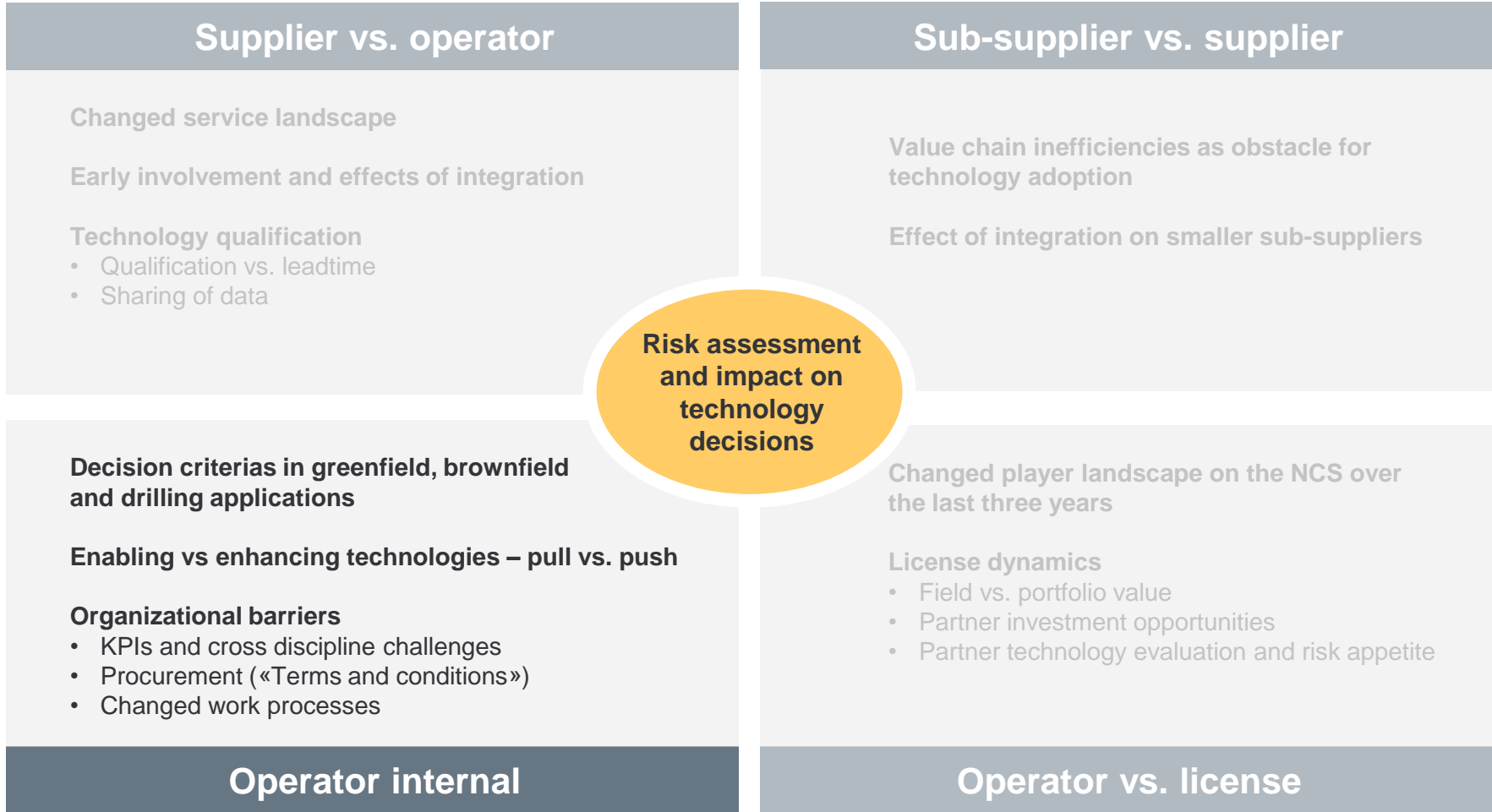
Drilling efficiencies improved massively during downturn – technology improvements or changed incentives?

Meters drilled per active drilling day* at NCS, by well type
Meters per day



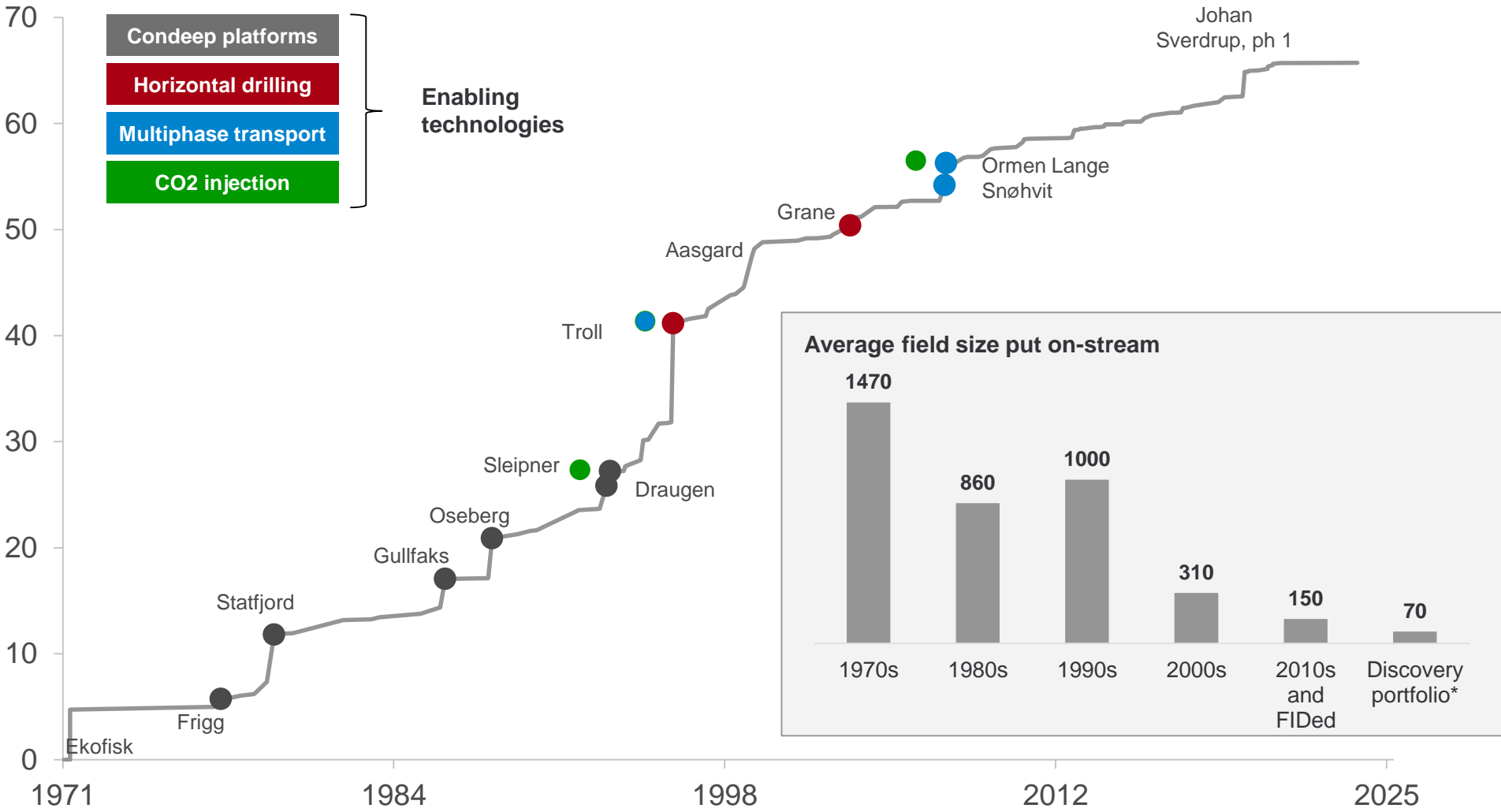
- **Drilling efficiency** as measured by meters drilled per active drilling day has fallen steadily towards 2015 at a rate of almost **-3% per year**. From 2015 to 2017 we saw massive improvements in drilling performance.
- Massive **oversupply** in the rig market led to **performance incentives** for rig owners in order to secure new contracts, despite being on day rate contracts.
- **Influx of newer rigs and several changed/upgraded derricks** on fixed installations are also an important part of the equation – the industry simply started to fully utilize new technology.
- **Fast adoption made possible by large number of applications** which is typical for drilling technologies

Note: Meters drilled = Measured Max Well depth - Water depth – Kelly Bushing. For sidesteps, we have estimated starting point of the side step based on an assumption that drilling speed is the same as the drilling speed in the main wellbore. *Includes all offshore activities, and is not a to be considered as meters drilled (ROP) when actual drilling. Sources: NPD; Rystad Energy research and analysis



New tech pivotal for the largest fields – current avg. NCS development too small?

Cumulative resource development on the NCS by start-up year and field
Billion barrels of oil equivalents



Sources: Rystad Energy research analysis; Rystad Energy UCube

What's enabling and enhancing from an environmental tech in oil and gas

Enhancing

Most environmental technologies are enhancing, they are not unlocking fields.

Some examples

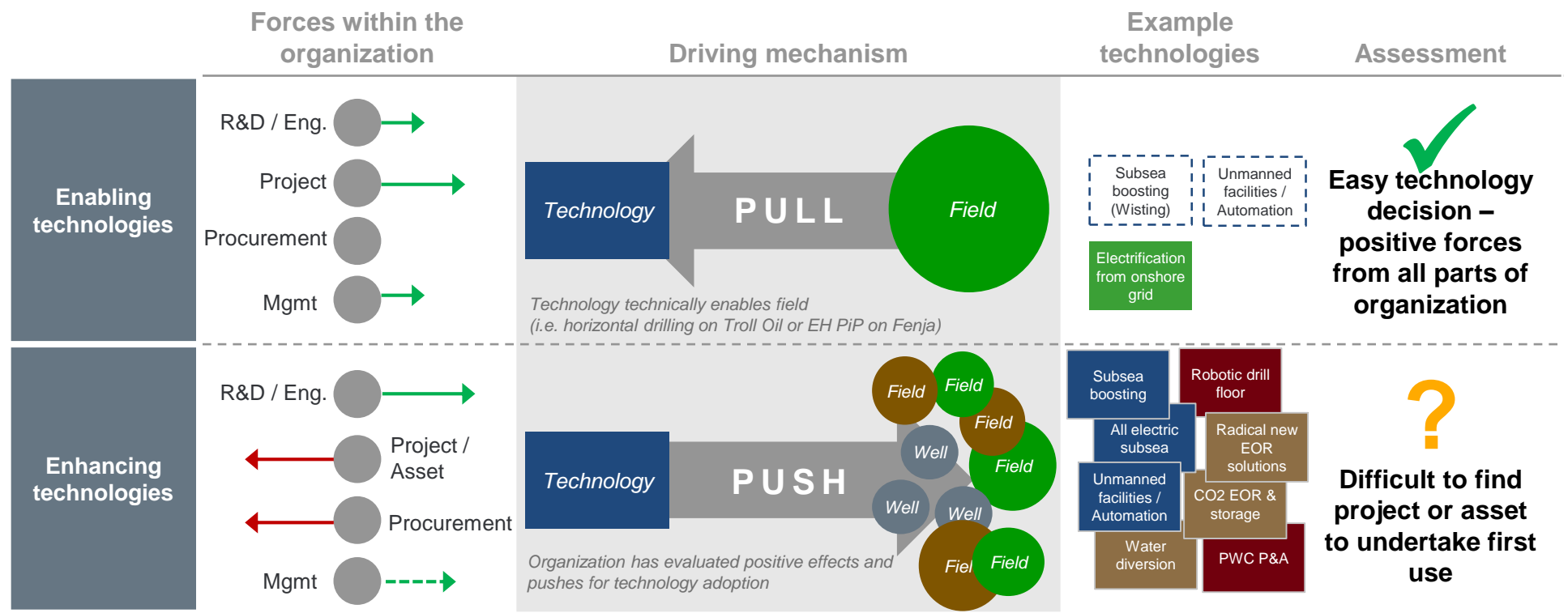
- Environmentally friendly EOR chemicals – *more volumes in existing fields*
- Subsea injection of dispersants – *lower costs*
- Cuttings treatment offshore (TCC) - *lower cost*
- Leak detection systems – *lower consequence = lower cost*
- Subsea CO2 separation and injection – *lower cost and more volume*
- Windmills to power water injection

Nice to have

Enabling

- **Social license to operate!**
 - No license to operate, no oil.
 - Regulator more important than in any other technology area in forcing adoption of technologies, making enhancing technologies enabling

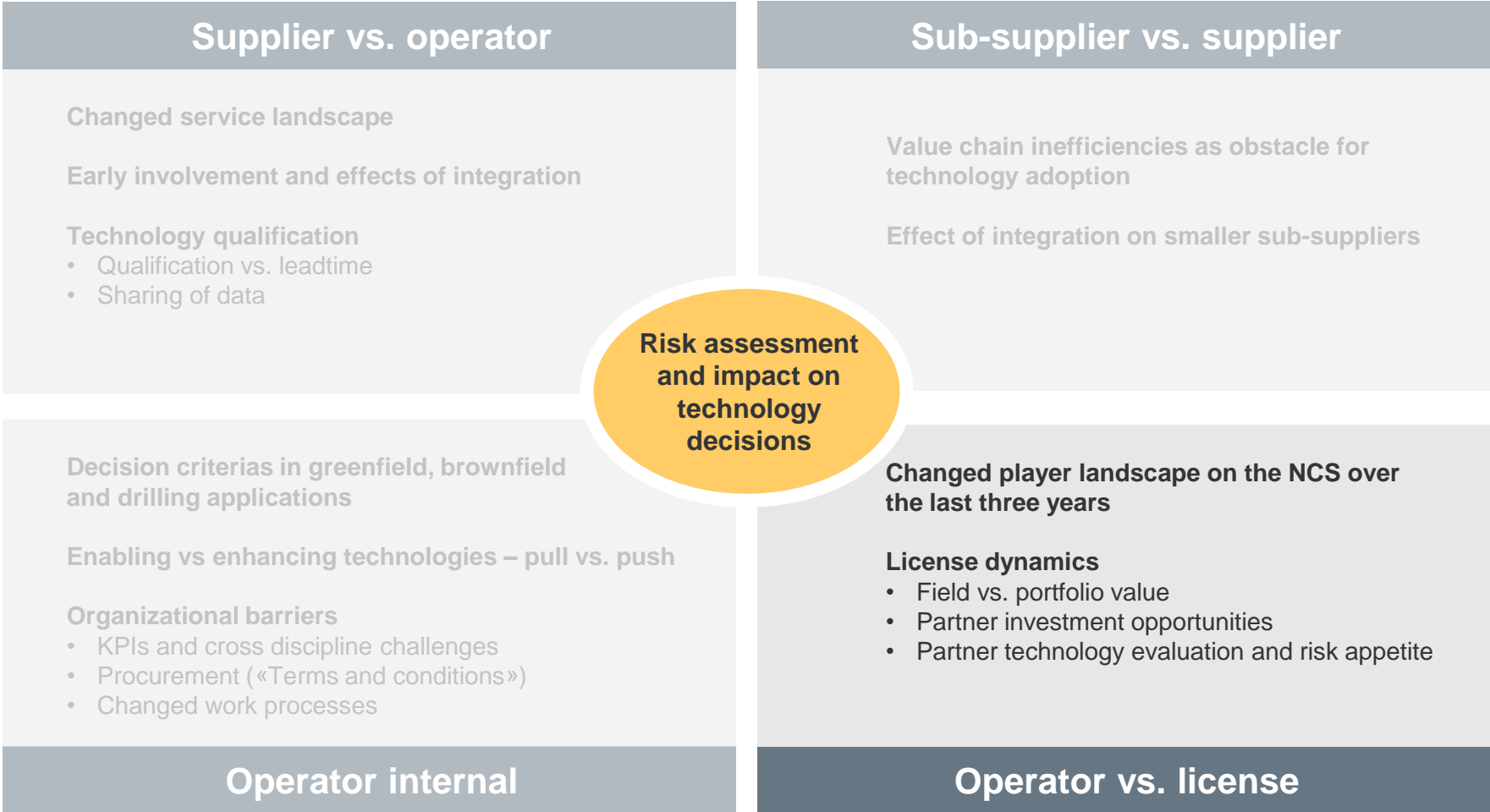
Need to have



Source: Rystad Energy research and analysis



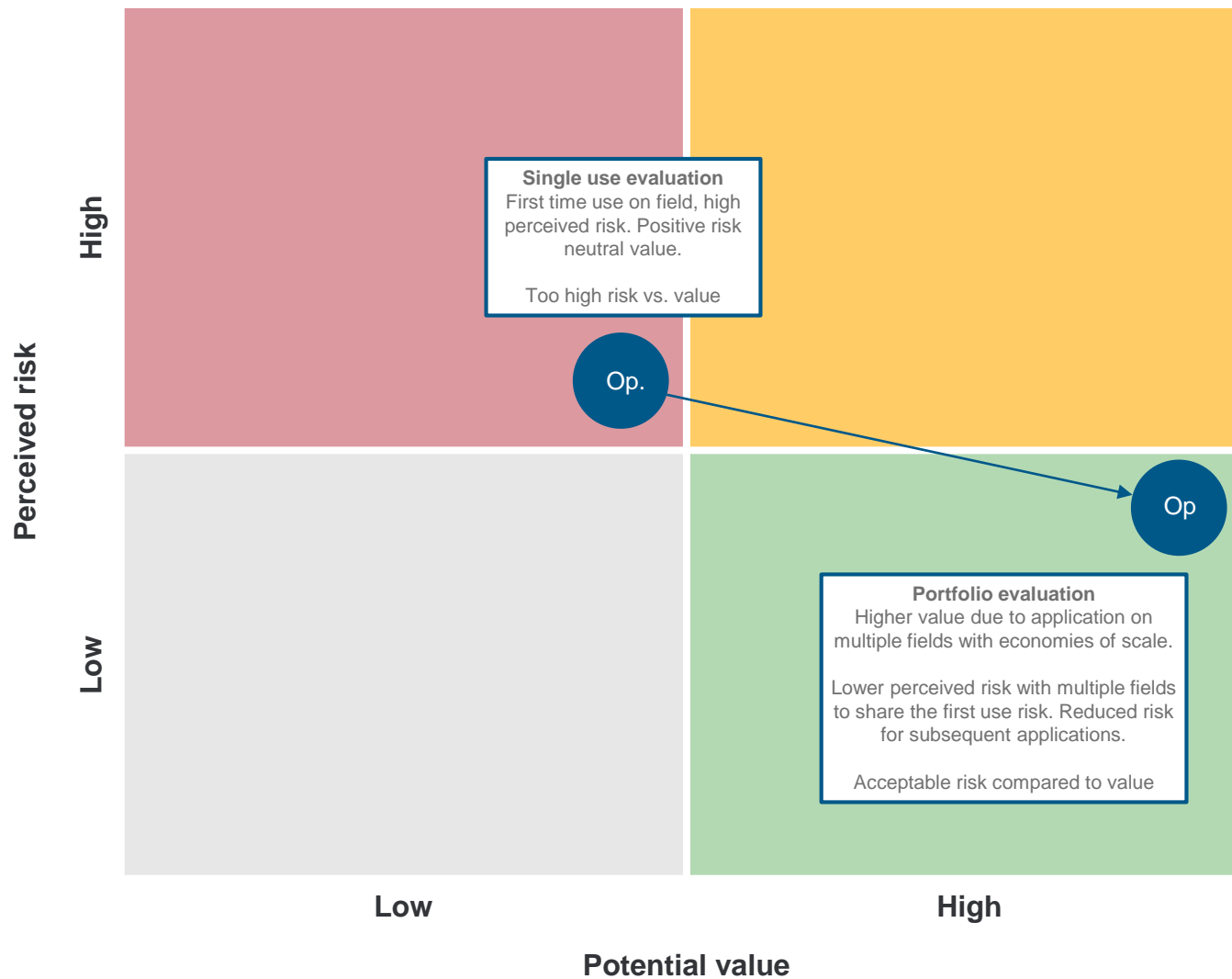
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Source: Rystad Energy research and analysis

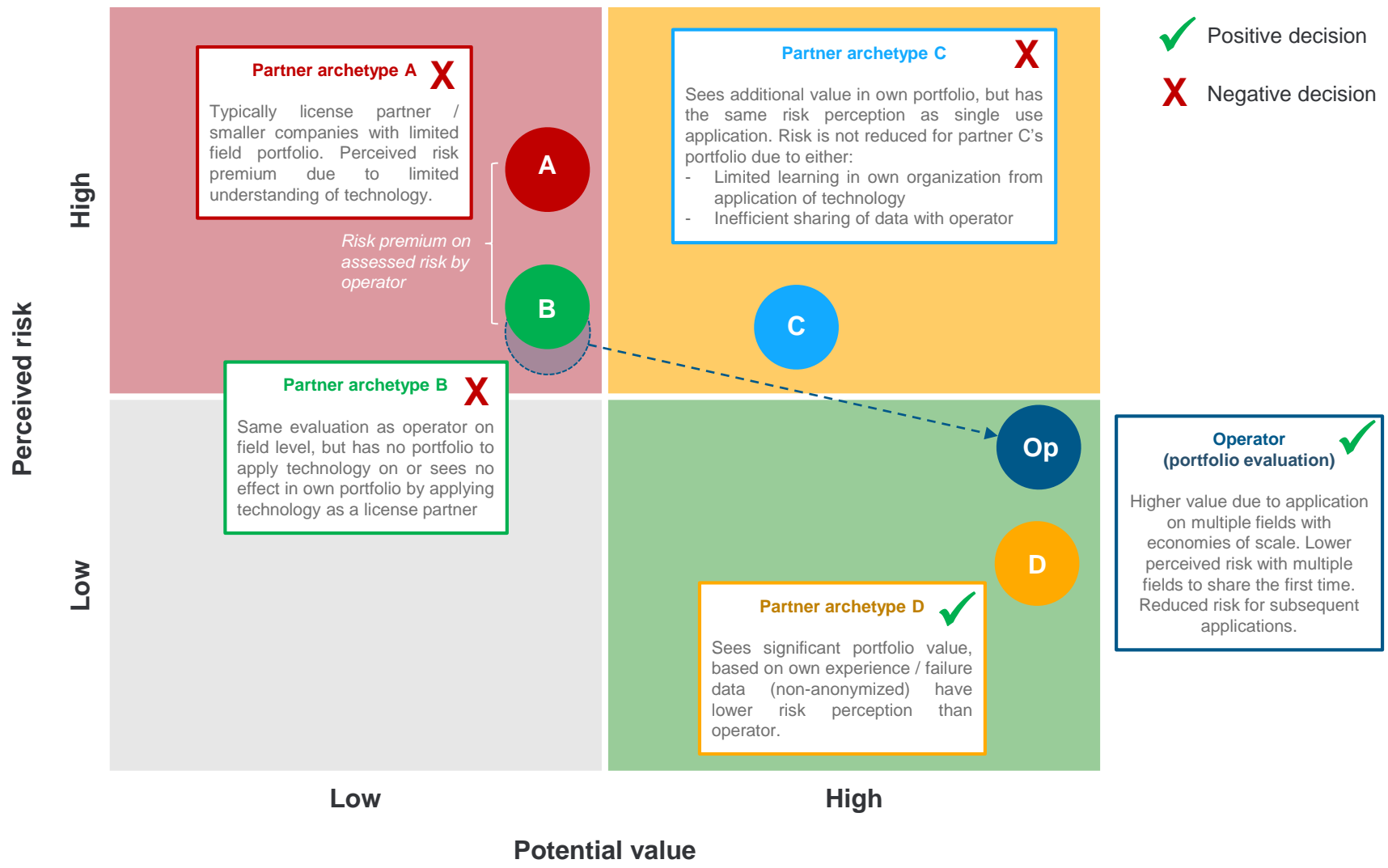


Risk – value matrix



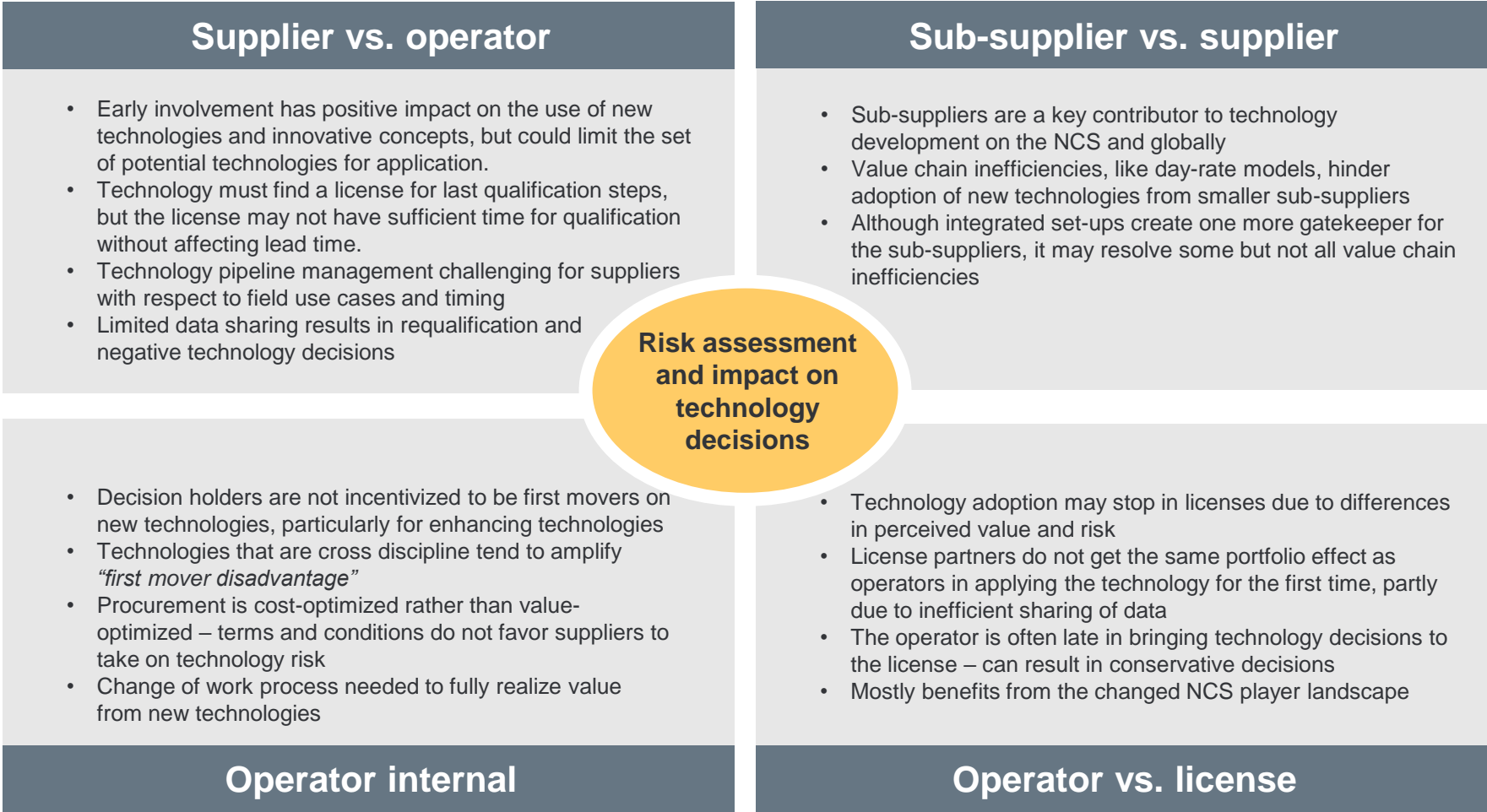
Source: Interviews; Rystad Energy research and analysis

Risk – value matrix



Source: Interviews; Rystad Energy research and analysis

Key take-aways from the four perspectives



Source: Rystad Energy research and analysis