

Water Management: Scarcity, Environmental Standards, Solutions

水资源管理：资源匮乏、环境标准、解决方案

14th US-China Oil & Gas Industry Forum

第十四届中美油气工业论坛

April Sharr

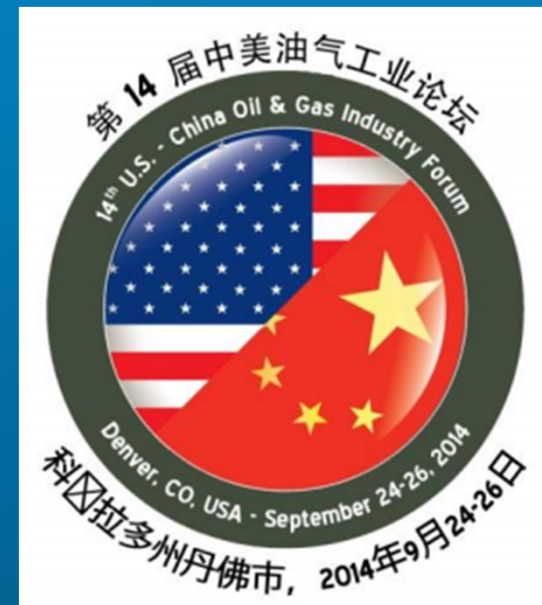
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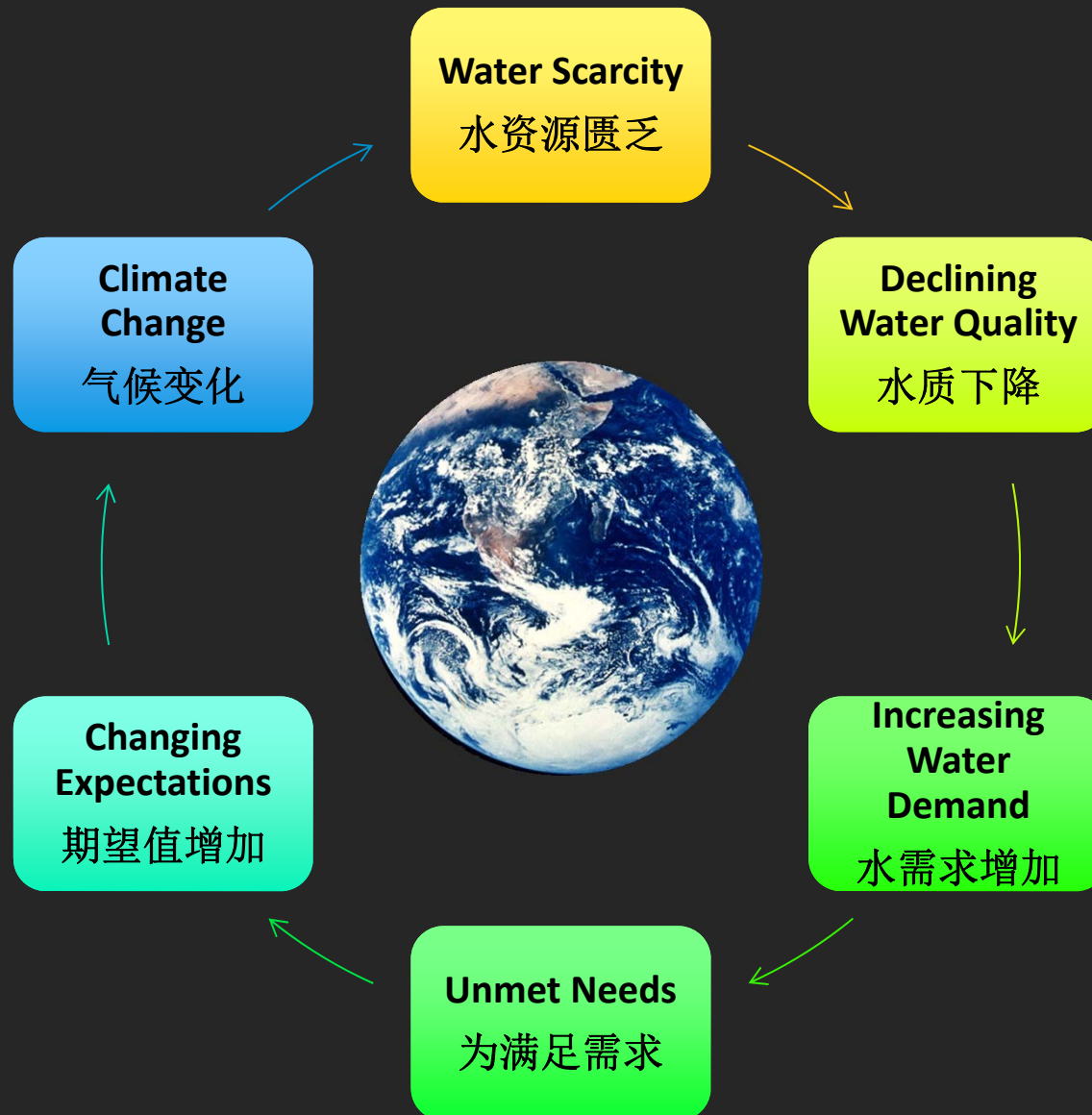
Enabling safe, affordable energy, improving people's lives

提供安全、经济的能源，提高人们生活质量

September 24 – 26 2014, Denver, CO



Global Water Challenges Increasing 全球面临日益严峻的水资源挑战



Water Use to Develop Energy Becoming Critical Tipping Point

开发能源用水成为关键转折点

6% of US energy consumption goes towards moving water around the country, although this rises to >20% in some areas, including CA

美国6%的能源消耗用于将水运送到全国各地，有些地方这个比例达到20%

The water-scarce Arabian Gulf region relies on energy-intensive desalination processes to produce water, with water costs rising alongside fuel costs

缺水的阿拉伯海湾地区依赖于能源密集型海水淡化过程产生的水，水的成本上升导致燃料成本上升

China is preparing to invest nearly \$100B in capex to move water from its southern regions to the more arid north 中国花费近千亿美元用于南水北调工程

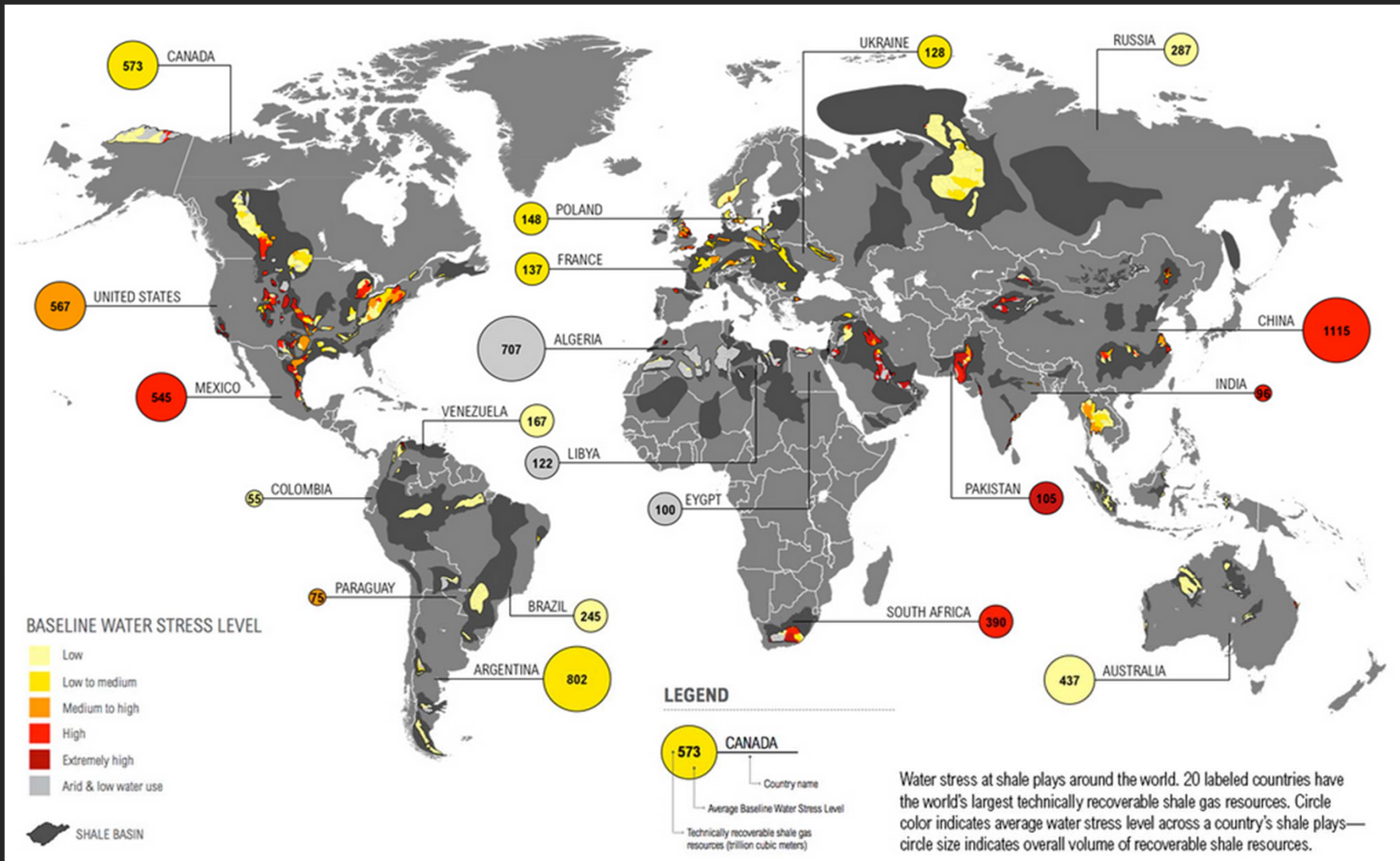
Energy and mining companies in Peru are repealing stringent regulations and building wastewater treatment plants for municipalities to fulfill their own water needs 秘鲁能源和矿业公司废除严格的法规，并建污水处理厂实现自己的水需求

In January 2014, the World Bank launched its “Thirsty Energy” initiative pilot in South Africa to develop “water-efficient energy, energy-efficient water” and the tools to plan and manage these two resources together. 2014年1月，世界银行推出“渴能”的倡议，引导南非发展“节水节能，用高效节能的水”，跟其他工具一起计划和管理这两个资源

Global Water Stress Map

40% of Countries with Largest Shale Resources Face Water Stress

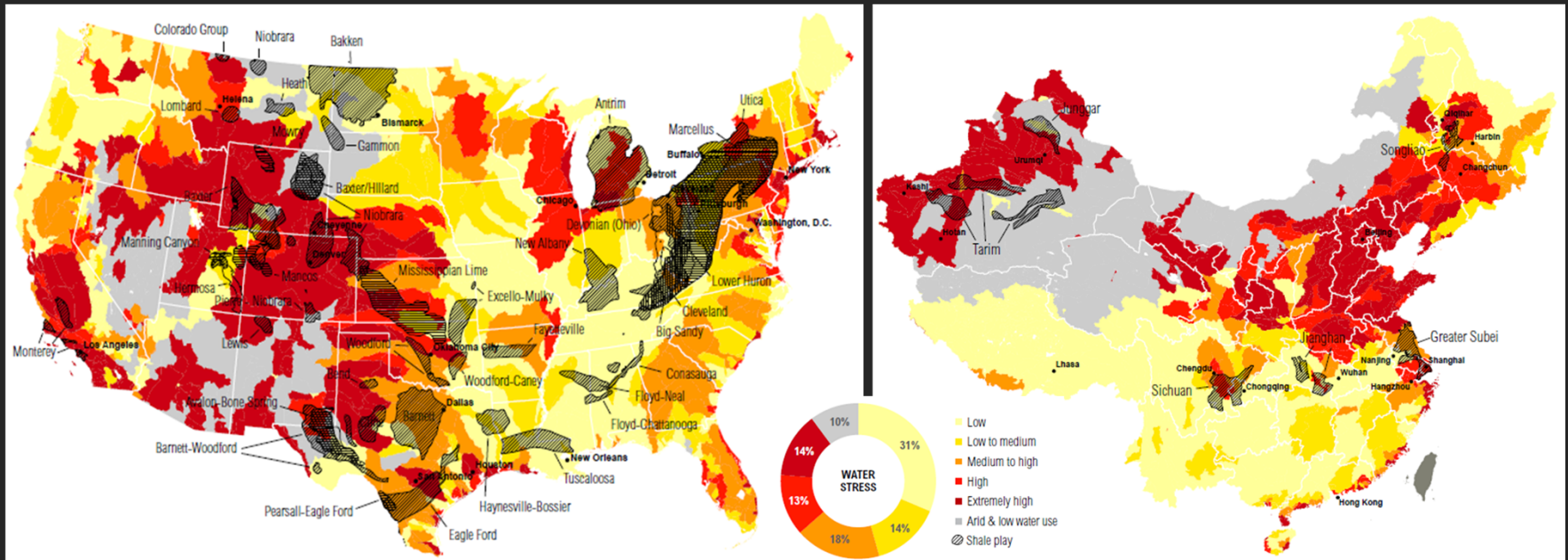
40%拥有大量页岩资源的国家面临用水压力



Source: World Resources Institute: Global Shale Gas Development, 2014

US and China Both Face Water Availability Constraints

中国和美国都面临着水资源约束



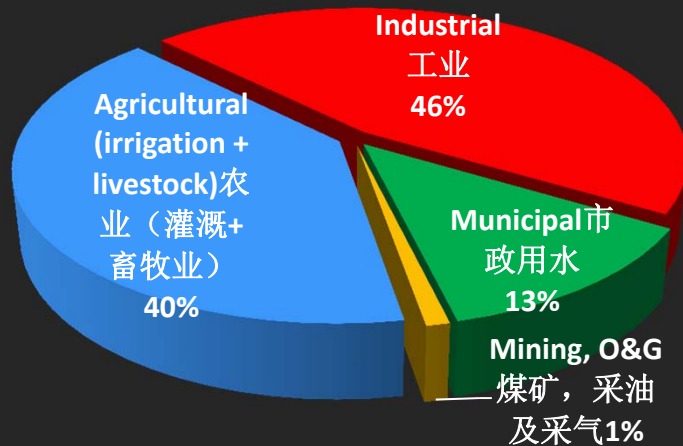
Source: World Resources Institute: Global Shale Gas Development, 2014; The World Bank, Data

- World's 3rd largest water user 世界第三大用水国家
- Over 35% of shale plays are located in arid or high baseline water stress areas 超过35%的页岩分布于干旱或是高基线区域
- 10 plays sit on top of aquifers that are being withdrawn at rates that exceed their natural recharge rate 10个位于含水层上部的作业地，正以远高于补给率的速度供水。
- Responsible for 12% of water withdrawals globally 占全球取水量的12%
- World's 2nd largest water user 世界第二大用水国家
- Over 60% of shale plays are located in arid or high baseline water stress areas 超过60%的页岩分布于干旱或基线高区域
- Baseline water stress in Sichuan is mixed, while over 95% of the Tarim is under high stress 四川的水基线有高有低，但在塔里木，超过95%都处于高应力下
- Responsible for 14% of water withdrawals globally 占全球取水量的14%

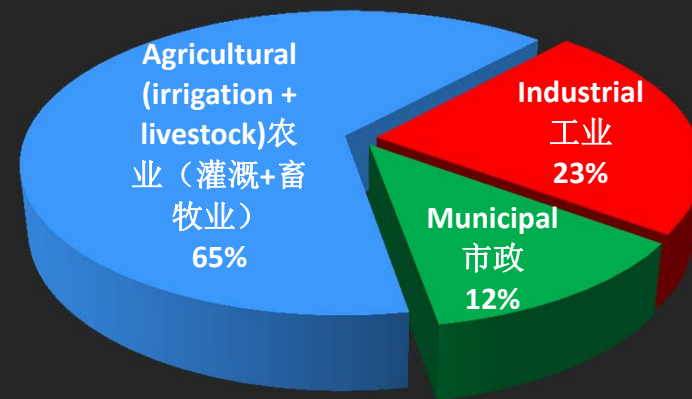
Constraints Increase Competition Amongst End Users

用水限制加剧了最终用户们之间的竞争

US Water Consumption 美国水资源消耗



China Water Consumption 中国水资源消耗



Source: FAO, Aquastat Database, 2005 data

- By 2060, water demand is expected to exceed available water supply 预计到2060年，用水需求将超过水供给能力
- Expanding population will increase water needs for people, business and agriculture 人口膨胀会提高人口、商业及农业的用水需求
- Optimal water management strategy balances growing water requirements, regional shortages, environmental impacts, and public concerns to maintain usable water supply 优化的水管理策略能平衡不断增长的用水需求，区域性用水短缺，环境的影响，并保持可用水供应的公众关注。

Federal and State Regulations Govern Oilfield Water 联邦和各州管理油田水相关法规



Safe Water Drinking Act (SWDA)

Underground Injection Control Program

Clean Water Act (CWA)

**National Pollutant Discharge Elimination System
Spill reporting and spill prevention**

**Resource Conservation and Recovery Act
(RCRA)**

**O&G exploration wastes not regulated as hazardous
Imminent and Substantial Endangerment Provision**

**Comprehensive Environmental Response,
Compensation and Liability Act (CERCLA)**

**Hazardous substance release program
Imminent and Substantial Endangerment Provision**

**Emergency Planning and Community Right-
to-Know Act (EPCRA)**

**Reporting on use, inventories, and releases into the
environment of hazardous and toxic chemicals
above threshold quantities**

State Regulations 州立法规

Texas: Model for Water Management?

德克萨斯：水资源管理模式？



- Over 100 technical and complex oil and gas regulations, active inspection program 超过100个技术和综合油气法规，及主动检测程序
- No confirmed case of groundwater contamination due to fracturing to date 没有确切案例表面压裂会造成地下水污染
- P&A abandoned wells to prevent groundwater contamination (2011) 堵住废弃井以防止地下水受到污染
 - *Oil & Gas Regulation and Cleanup Fund (Senate Bill 1, 82nd Legislature)*
- Improved transparency and communication with industry and communities (2011) 提高工业与民众之间的透明度及联系
 - *Eagle Ford Shale Task Force, South Texas Energy and Economic Round Table (STEER), Eagle Ford Consortium, West Texas Energy Consortium, Barnett Shale Energy Education Council (BSEEC)*
- Requires mandatory reporting of chemicals used in frac fluid (2012) 强制需要压裂液中所用化学品的报告
 - *Hydraulic Fracturing Disclosure (Statewide Rule 29, Texas Administrative Code, Title 16, Part 1, §3.29)*
- Established stringent well-integrity, well-construction rules (2013) 建立严格的完井及建井规则
 - *Casing, Cementing, Drilling, Well Control, and Completion Requirements (Statewide Rule 13, Texas Administrative Code, Title 16, Part 1, §3.13)*
- Encouraged water recycling and conservation in the oilfield (2013) 鼓励油田实施水的回收利用和保存
 - *Water Protection (Statewide Rule 8, Texas Administrative Code, Title 16, Part 1, §3.8), Texas HB 2767 (83rd Legislature), Texas Water Recycling Association*
- Coordinate among energy producing states to share best practices, challenges 协调各能源生产州之间分享最佳做法及遇到的挑战
 - *Membership in Interstate Oil and Gas Compact Commission (IOGCC), "States First" initiative, State Oil & Gas Regulatory Exchange (SOGRE), State Review of Oil & Gas Environmental Regulations (STRONGER), Independent Petroleum Association of America (IPAA)*

Alternative Water Solutions for Unconventional Development

不同的非常规资源开发用水解决办法

Use Less
Water
少用水

Brackish
Water
用盐水

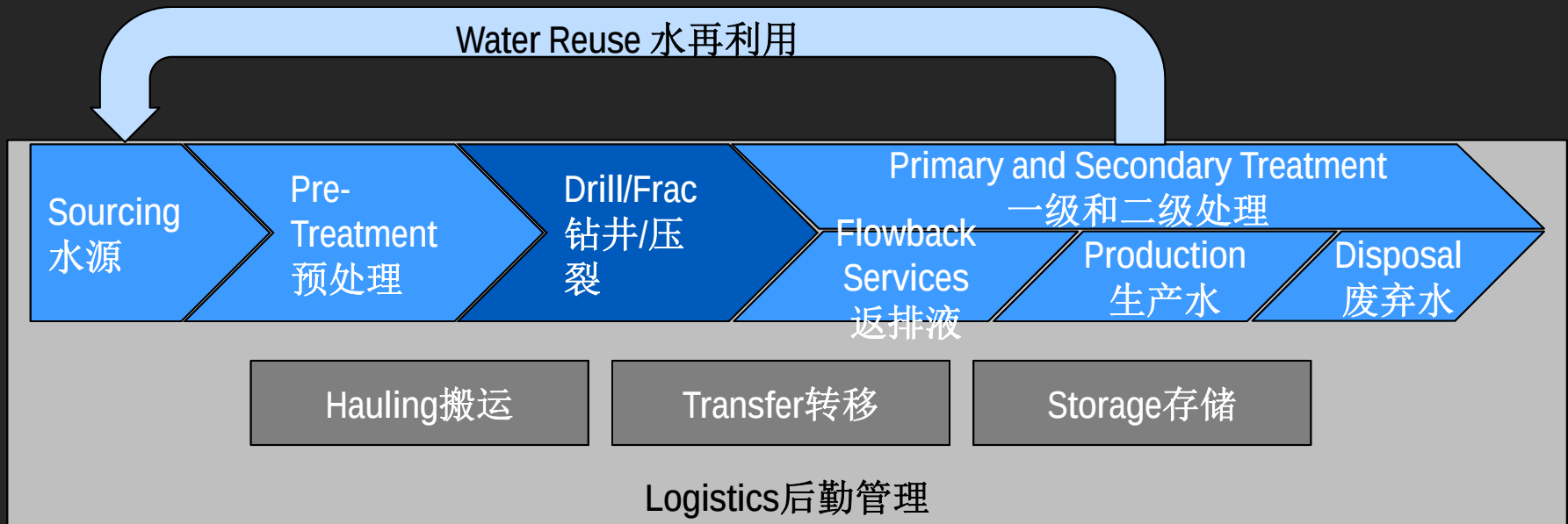
Blended
Water
用混合水



Waste Water
用废水

Recycle
Produced Water
循环利用生产
水

Water Management Value Chain 水处理价值链



Sourcing 水源

- Purchase and procurement of water for oilfield use 购买油田用水

Pre-Treatment 预处理

- Primarily chemicals additives prior to frac 压裂前添加化学添加剂

Flowback Services 返排液处理

- Flowback fluid processing services during well test period 试井阶段进行返排液处理服务

Treatment 生产水处理

- Treatment of produced and flowback water 生产水及返排液处理

Disposal 废弃

- Injection wells are the preferred approach for handling water 注入井是处理水的首选方法

Hauling 搬运

- Hauling source, flowback and produced water from the field and to disposal, treatment or other well sites via water hauling trucks 井场的水源、返排液、生产水的废弃、处理搬运工作，或者是运送至其它井场所需运水车

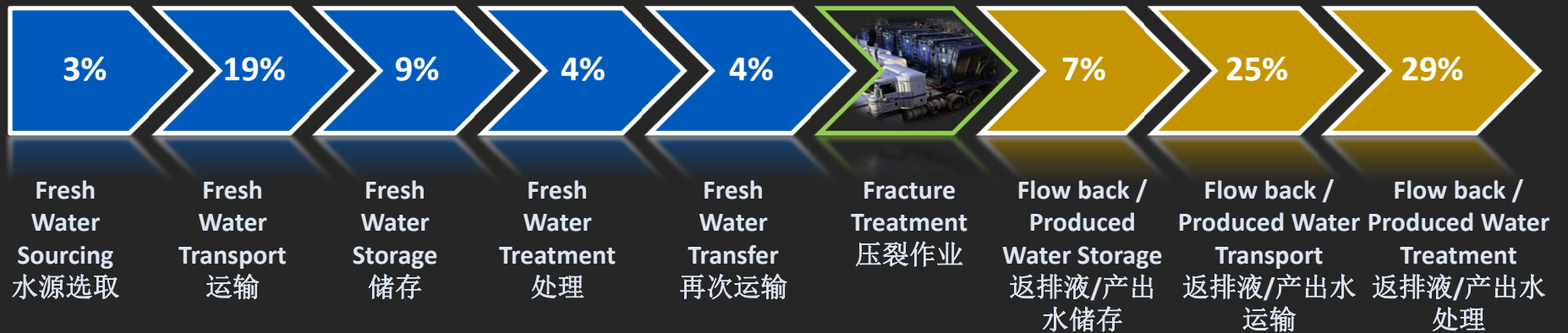
Transfer 转移

- The transportation of water from the field and to disposal, treatment or other well sites via water transfer pumping 从井场到废弃、处理或去其它井场，水的转移工作

Storage 存储

- Field water storage products & services, including tank rentals 井场存储水所需产品及服务，包括租赁水罐

The Cost of Water 水费用组成

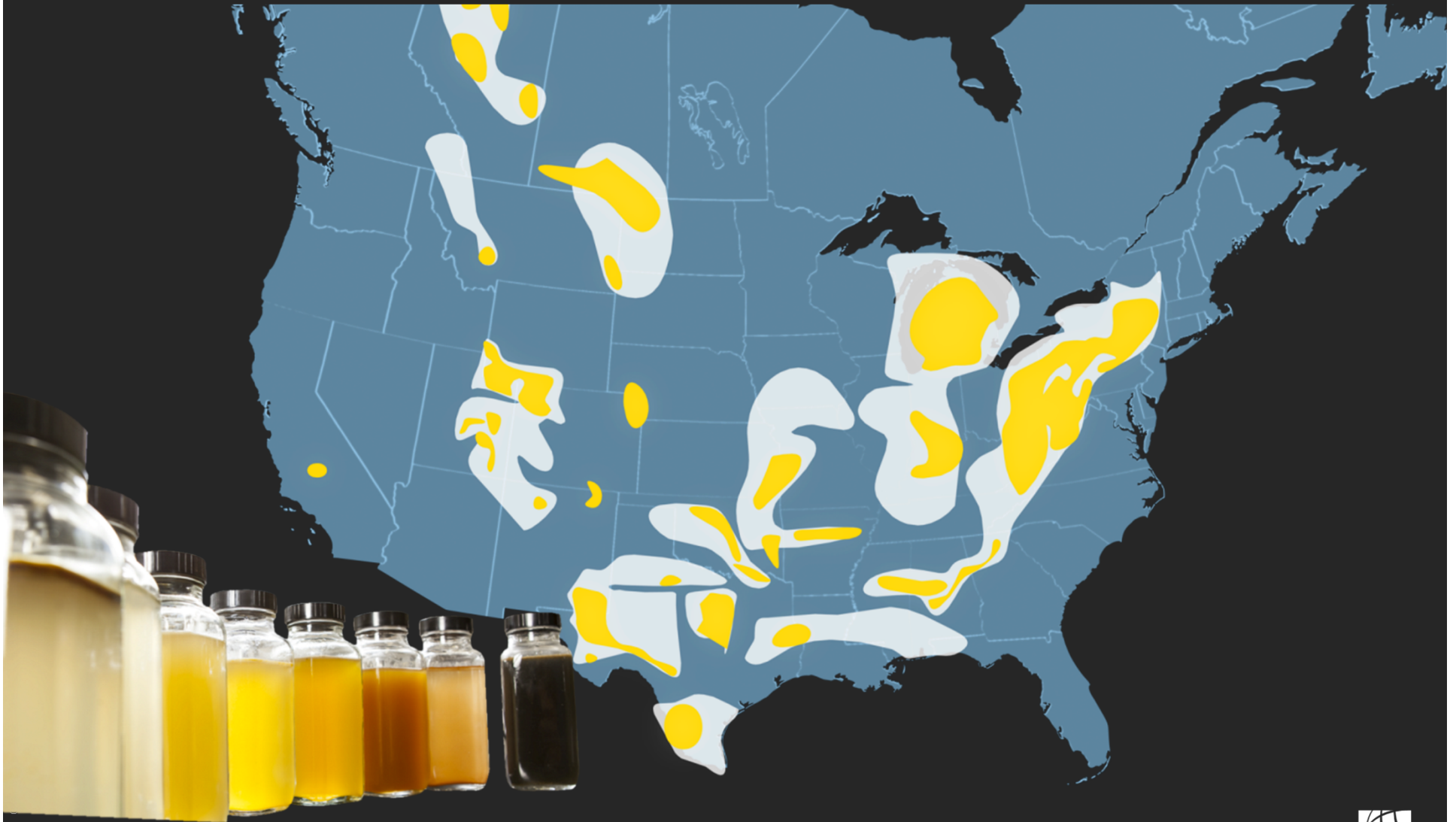


Hidden costs 隐藏费用

- ❑ Lifting and transport 取水和运输
- ❑ Treatment 处理
- ❑ Disposal 清理
- ❑ Production chemicals 化学品产出
- ❑ Solids Production 固体产出
- ❑ Tubulars de-rating/replacement 管柱重入/替换
- ❑ Facility throughput limits 设备生产能力限制

Local Conditions Drive Water Management Strategies

因地制宜的水处理策略



The Reduce and Recycle Value 减少及回收的价值

■ *More Hydrocarbons* 更多碳氢化合物

- Enhanced production 提高产量

■ *Environmental Stewardship & Conservation* 环境管理和保护

- Use of environmentally preferred chemicals 使用环境优先的化学品
- Decreased water production 减少产水量
- Waste turned into useable product 变废为宝
- Reduced fresh water demand 减少淡水需求

■ *Safety* 安全

- Minimized heavy truck traffic 减少重型设备使用量

■ *Lower Costs* 降低成本

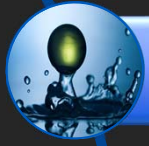


Baker Hughes Smart Water Management Toolbox 综述目录

Water Management Solutions 水处 理的解决方 案



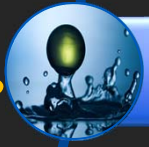
Pre-treatment Assessments 预处理评估



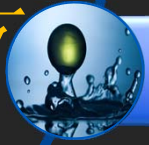
Recycling Solutions 循环利用解决方案



Flow Assurance 油气通道优化



Well Integrity 油井寿命优化



Reservoir Optimization 油藏优化



Post-treatment Monitoring 后处理监测

Why Baker Hughes? 为什么要选择贝克休斯?

- Address even the most challenging applications with the right **technology**

采用正确的技术解决行业最具挑战的问题

- Reduce, control and recycle your produced water to **enhance** initial **production**

降低、控制及循环利用产出水增强生产

- Meet industry's requirement for **environmentally preferred** products and services

采用环保的产品及服务，满足行业技术要求

- Treat any water with customized **cost effective** solutions

采用性价比高的个性化方案处理任何种类的水源

- Offer integrated solutions for **greater efficiency** and **reduce** required **footprint** for treatment

最大效率的一体化解决方案，降低现场处理占地面积



Questions? 欢迎提问

H2prO™ CLEAR, HD & SR
Produced Water Recycling 生产水的循环利用

SweepSCAN™
Well Communication Diagnostics 井筒的沟通与诊断

Flow Assurance
Sorbs and Well Integrity Products
除垢剂及保证井筒整体性产品

ResPro™
Reservoir Conformance & Remediation 储层的一致性与修复