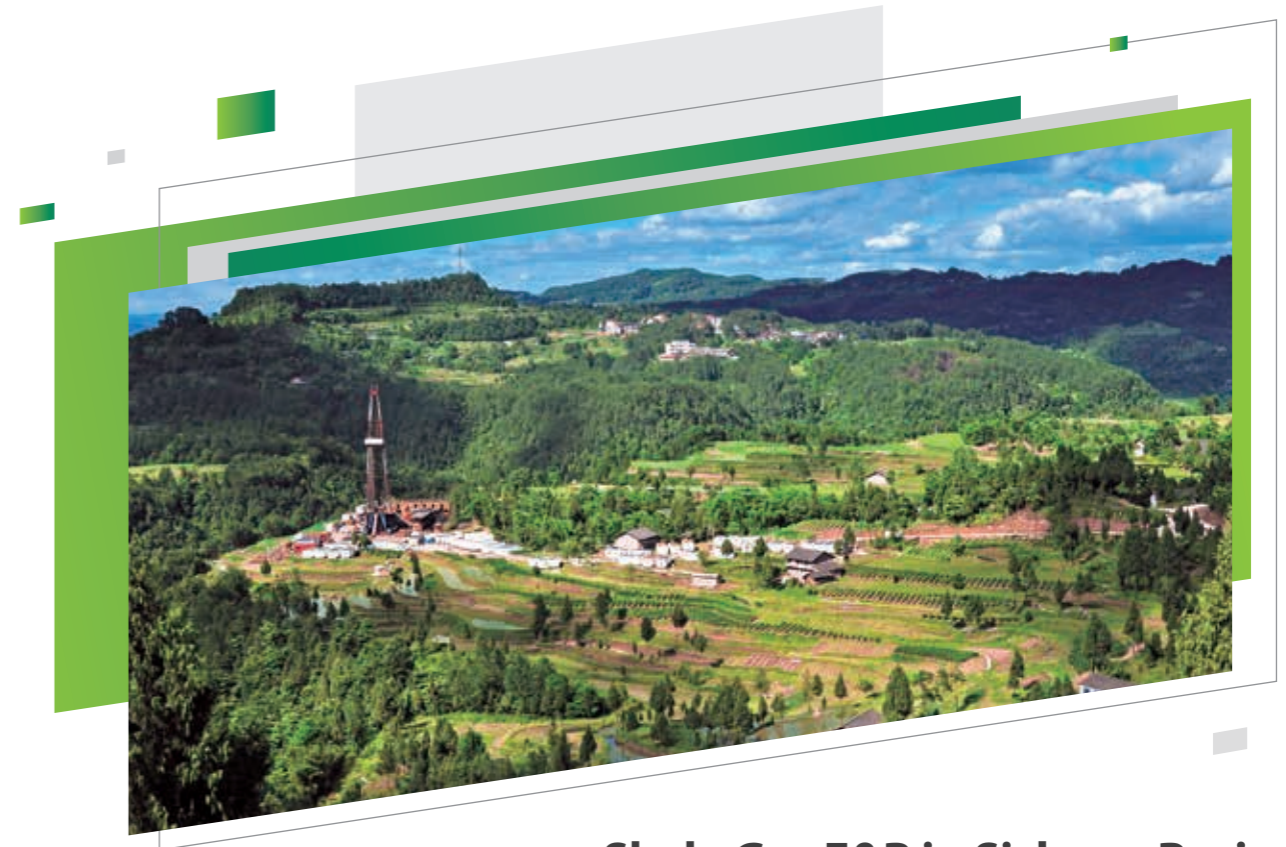


## Challenges in development

The Sichuan Basin features dense population and sensitive ecologic environment. Shale gas reservoirs there are characterized by large burial depth, high fragility and high risk of collapse, posing quite difficulties in wellbore engineering in long horizontal intervals. Even worse, poor drillability of the overlying formations may result in frequent leakage and collapses, and thus high drilling costs. Moreover, the surface conditions are complex because most wells are located in mountainous areas, where poor accessibility and limited fields make it difficult to carry out industrial operation. In particular, the water supply required by large-scale hydraulic fracturing cannot be ensured.

Based on ten years of R&D efforts, CNPC has identified shale gas resource bases and their distribution in the Sichuan Basin, and confirmed three capacity-building blocks. Main technology series for shale gas E&P have been configured, including comprehensive geological evaluation, development optimization, fast horizontal drilling, horizontal well SRV fracturing, factory drilling of horizontal well group, and environmentally friendly operation. The high-yield well fostering mode featuring geological and engineering integrated modeling, design and management has helped increase single well output continuously and resulted in better capacity-building effects.

The unique shale gas operation mechanism that integrates foreign and domestic cooperation and efficient development mode that features platform well location deployment, factory drilling and fracturing, skid-mounted gas production and gathering facilities, and integrated geological and surface engineering, have enabled cost-efficient development of shale gas at low gas prices. Meanwhile, environmental measures in land conservation, soil and water protection and water recycling have achieved excellent performance.



**Shale Gas E&P in Sichuan Basin**

**Energize · Harmonize · Realize**

China's Sichuan Basin harbors abundant shale gas resources, nearly a half of the nation's total.

CNPC owns 10 shale gas exploration rights of 46,800 km<sup>2</sup> in the Sichuan Basin.

CNPC took the leading in shale gas geological evaluation in China in 2006 and carried out pilot test in Sichuan in 2009. We launched the construction of the Changning-Weiyuan national shale gas demonstration block in 2012 and started scale shale gas production in 2014.



### 2006-2009 Resource evaluation and target area selecting

- ◆ **2006** Launched shale gas geological assessment and field survey for the first time in China
- ◆ **2007** Carried out joint research with US's Newfield Exploration Company at Weiyuan block
- ◆ **2009** Carried out joint evaluation with Shell at Fushun-Yongchuan block

### 2009-2013 Pilot test

- ◆ **2010** Completed China's first vertical shale gas well Wei 201, yielding gas flow after fracturing
- ◆ **2011** Completed China's first horizontal shale gas well Wei 201-H1, yielding gas flow after fracturing
- ◆ **2012** Completed well Ning 201-H1, yielding commercial gas flow for the first time in China
- ◆ **2013** Kicked off China's first factory experimental platform Changning H3 for shale gas production

### 2014-2016 Construction of demonstration blocks

- ◆ **2014** Put into operation China's first shale gas transport pipeline—Changning Pipeline
- ◆ **2015** Configured technological package for shale gas E&P and submitted proven reserves
- ◆ **2016** Completed Changning H9 platform, outputting over 1,500,000m<sup>3</sup>/d of shale gas during production test
- ◆ **2016** Produced 2.8bcm of shale gas

### Two national shale gas demonstration blocks, Changning-Weiyuan and Zhaotong, have taken shape with submitted proven shale gas in place of 163.5bcm.

Average test output per well increased to 209,000m<sup>3</sup>/d and costs per well reduced to 50 million yuan.

A total of 226 wells were completed and 183 wells were put into production after fracturing, building a production capacity of 10 million cubic meters per day. In 2017, the two demonstration blocks produced more than 3bcm of shale gas, with the cumulative production totaled 8.8bcm.

### Fushun-Yongchuan industrial production block has been confirmed.

Commercial gas flow was obtained at 20 wells, with maximum daily output per well of 430,000m<sup>3</sup> during production test and cumulative output of 236 million cubic meters.

### Breakthrough was obtained at Yuxi block.

Vertical appraisal well Zu 202 yielded 49,000m<sup>3</sup> per day during production test at a depth of 3,500-4,000m.

