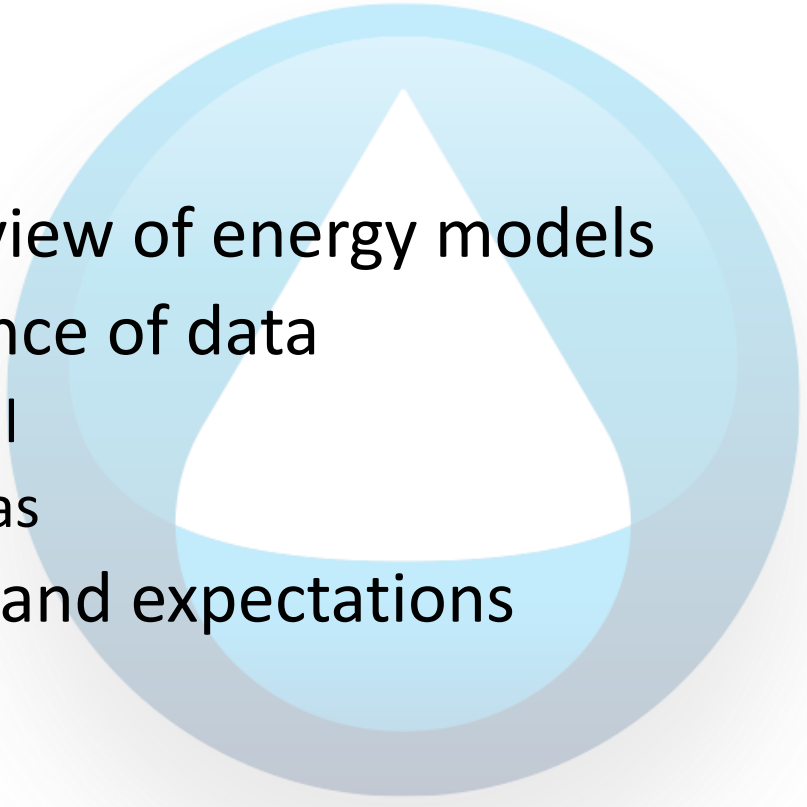# Use of JODI Data in Energy Modeling

Dr. Hossein Hassani (OPEC)
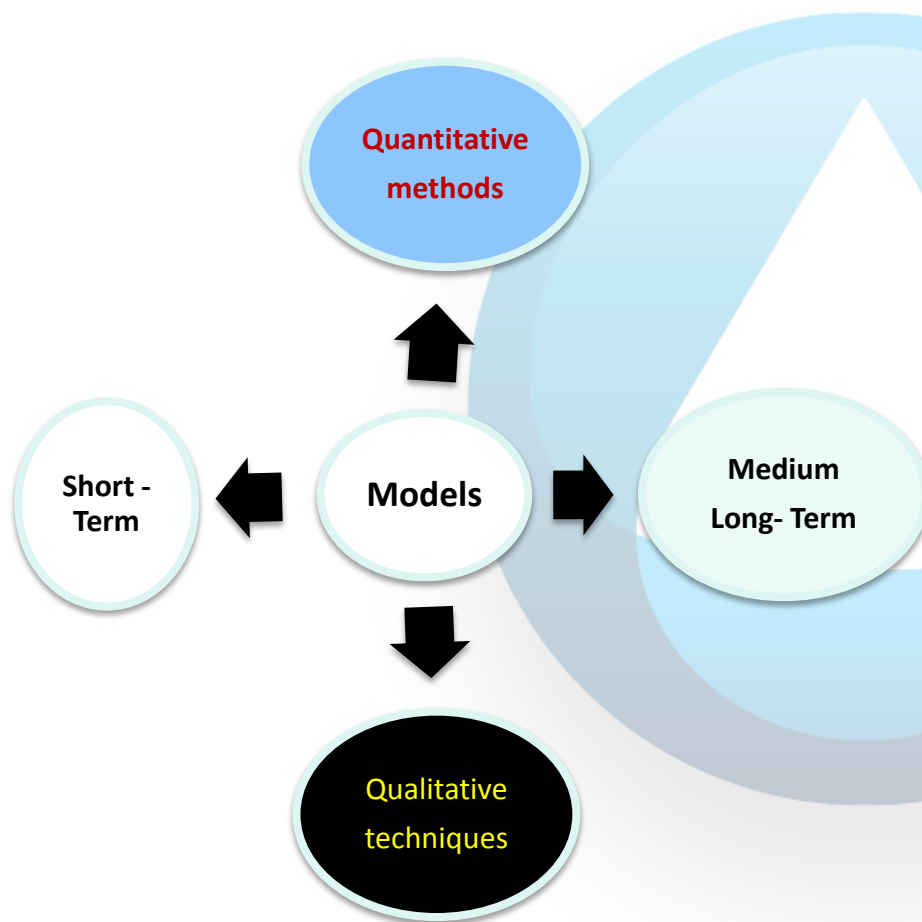**Dr. Pantelis Christodoulides (OPEC)**

Outline

- An overview of energy models
- Importance of data
  - JODI oil
  - JODI gas
- Outlook and expectations

An overview of energy models

Principal dimensions of energy modeling

Quantitative methods

Short - Term

Models

Medium Long- Term

Qualitative techniques

- Quantitative methods: the future is projected as some mathematical / statistical functions of historical data

- Qualitative techniques: based on expert judgment

- Short-Term forecasts: projections for the following 1-2 years
  - Quarters and months are required
  - Functions of data most times not-linear; data include seasonal and trend components

- Medium/Long-Term forecasts: for the upcoming 5/20-30 years
  - Basically long-term trend-related yearly projections

Quantitative methods

- <u>General pros and cons</u>
  - Stationary time series are required for applied models; for most of the cases this requirement is not given. Usage of transformed time series but this is also a challenge
  - Theoretical background is often not existing, especially when fitting complex functions on historical data (Over fitting)
  - If successfully fit, they could enhance forecasting (accuracy, statistically sound confidence intervals, simulations,…)
  - Objectiveness

- <u>3 main categories of quantitative approaches</u>
  - Time series
  - Econometric models
  - Equilibrium models

Quantitative methods

- <u>Time series methods</u>
  - Moving averages
  - Seasonality and trend filters
  - Smoothing techniques
  - AR(I)MA models
  - Extrapolation
  - Any other method that would fit the underlying oil-related process

- <u>Econometric models</u>
  - Regression (parametric and non-parametric)
  - ARMAX models

- <u>Equilibrium models</u>
  - Supply/demand and prices as part of an overall/partial equilibrium
  - For Medium/Long-Term forecasts

Quantitative methods – additional concepts

- Inclusion of forecasting accuracy procedures
  - Confidence intervals
  - Simulations
- Applications of other methods
  - Artificial intelligence
  - Data mining and pattern recognition techniques
  - Probabilistic forecasting

Qualitative techniques

- ## Delphi method
  - – Relies on expert panels. Combined and collective knowledge as the basis for forecasts
  - – Useful in cases where quantitative models are either too complex and/or cannot be established. Based to a large extend also on quantitative knowledge
  - – Often subjective and depends on the structure of the panel used

- ## Forecasting by analogy
  - – Modeling of variables in similar terms to other variables, which are known
  - – Improved accuracy as compared to the Delphi method
  - – Analogies sometimes unknown
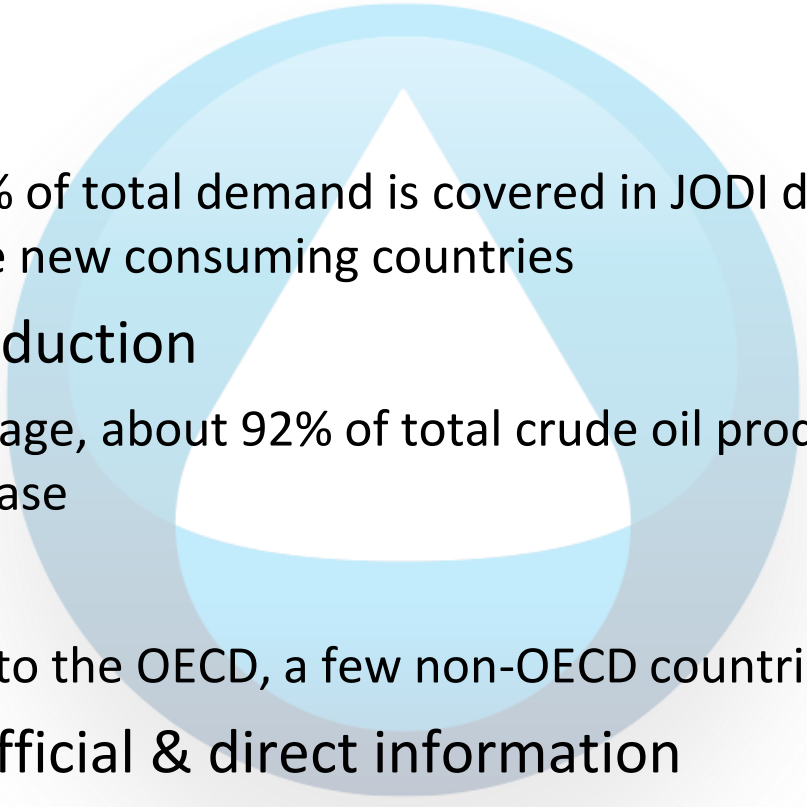
Qualitative techniques

- Technology forecasting
  - Assumption of technological characteristics as the base for forecasts
  - Combined forecasts – extrapolation and growth curves
  - Useful tool when combined with other methods
- Scenario building
  - Analysis of possible future events under consideration of alternative outcomes
  - Usually optimistic and pessimistic scenarios
  - Development paths become observable; valuable information

JOINT ORGANISATIONS DATA INITIATIVE

Importance of JODI oil data

Important JODI oil flows

- Demand
  - Demand forecasts are based on consumption data subject to a certain time lag, among other factors – the accuracy of the base year is essential in estimating the year ahead

- Non-OPEC supply
  - Non-OPEC supply forecast is based on a bottom-up approach, adding growth projections to an existing baseline – the base is essential in estimating the year ahead

- OPEC production
  - Added to non-OPEC supply, global supply indicates the status of the market (loose vs. tight) when compared to total world oil demand

- Global stocks
  - Oil inventories should reflect interaction between supply and demand forces – the global picture of stocks is the ultimate tool for checking supply and demand numbers
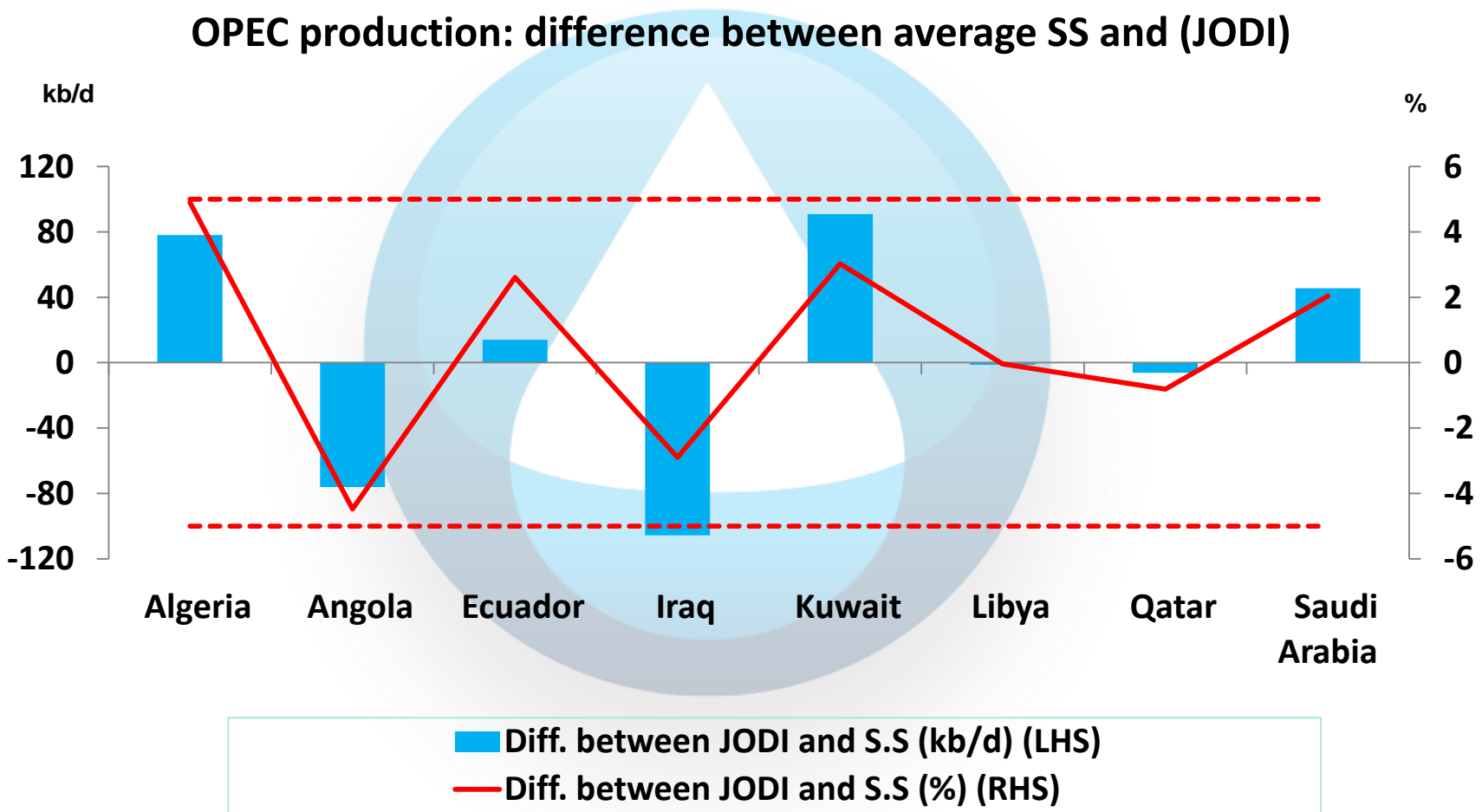
Advantages of using JODI oil data

- Demand
  - Around 83% of total demand is covered in JODI data base, including some of the new consuming countries

- Crude oil production
  - Large coverage, about 92% of total crude oil production is covered in JODI data base

- Inventories
  - In addition to the OECD, a few non-OECD countries are also covered

- JODI data - official & direct information

Advantages of using JODI oil data

- Refinery
  - Around 86% of total refinery intake and output are covered in JODI database
- Trade
  - Large coverage, about 88% of total oil exports and imports are covered in JODI database
- Time lag
  - Improvement in time lag, two months for many countries
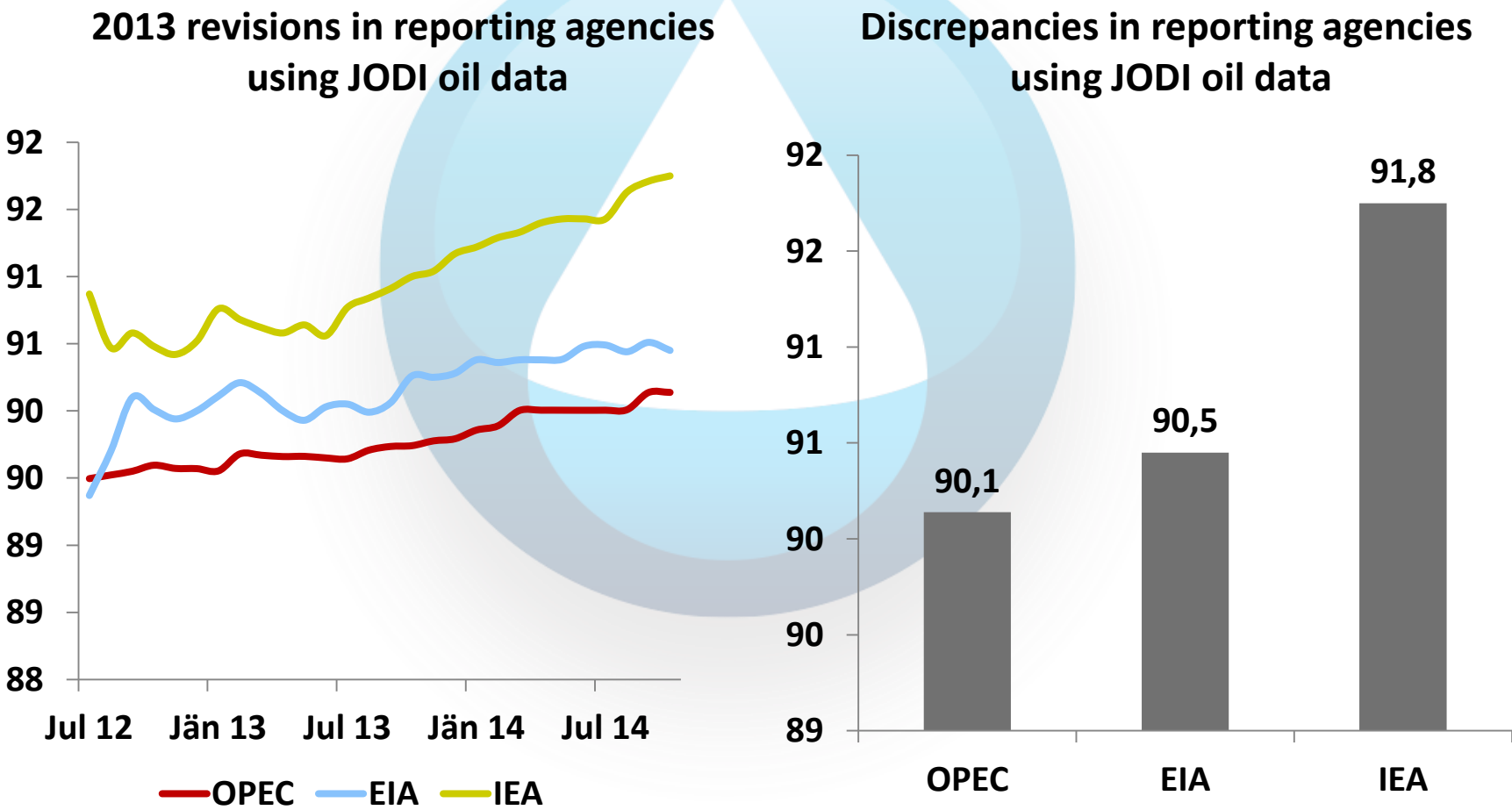
Advantages of using JODI oil data

OPEC production: difference between average SS and (JODI)

Legend:
- ■ Diff. between JODI and S.S (kb/d) (LHS)
- — Diff. between JODI and S.S (%) (RHS)

Categories: Algeria, Angola, Ecuador, Iraq, Kuwait, Libya, Qatar, Saudi Arabia

Shortcomings of JODI oil data

- World oil demand
  - Lack of data for the main consuming countries (China, Russia, Singapore, UAE…)
  - Considerable revisions in reporting organizations/agencies using JODI oil data
  - Large discrepancy among reporting organizations/agencies using JODI oil data, even for countries for which data is available in JODI (Indonesia, Thailand, Malaysia,…)

World oil demand, *mb/d*

2013 revisions in reporting agencies using JODI oil data

— OPEC — EIA — IEA

Discrepancies in reporting agencies using JODI oil data

OPEC	EIA	IEA
90,1	90,5	91,8

A Concrete Outcome of the Consumer - Producer Dialogue
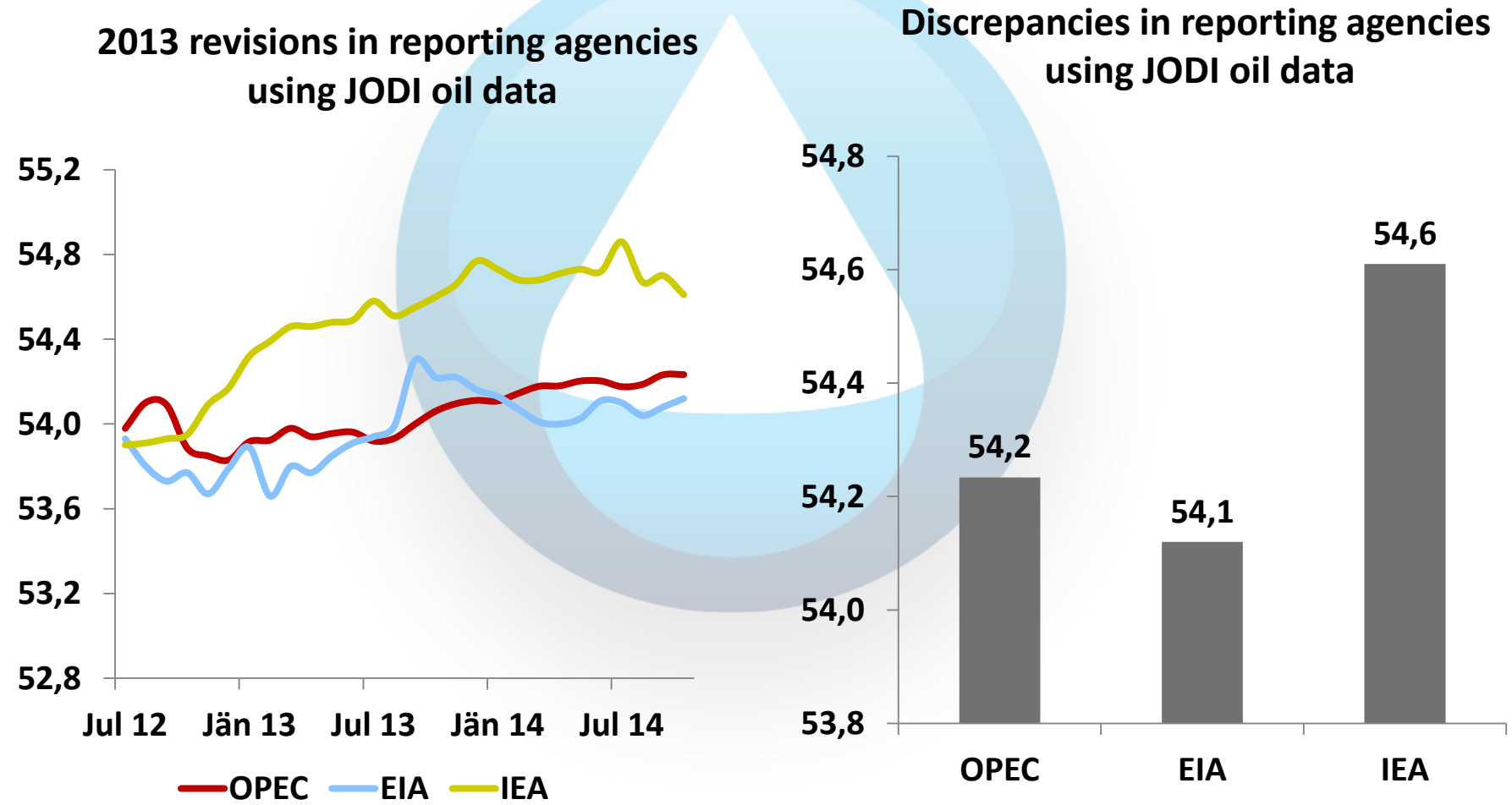
JOINT ORGANISATIONS DATA INITIATIVE

Shortcomings of JODI oil data

- ## Global supply
  - ### Total crude production
    - Insufficient coverage provides a poor base in estimating the period ahead (1.0% missing ~ 0.7 mb/d)
    - Revisions in historical data by organizations/agencies
    - Discrepancy among various sources
  - ### OPEC production
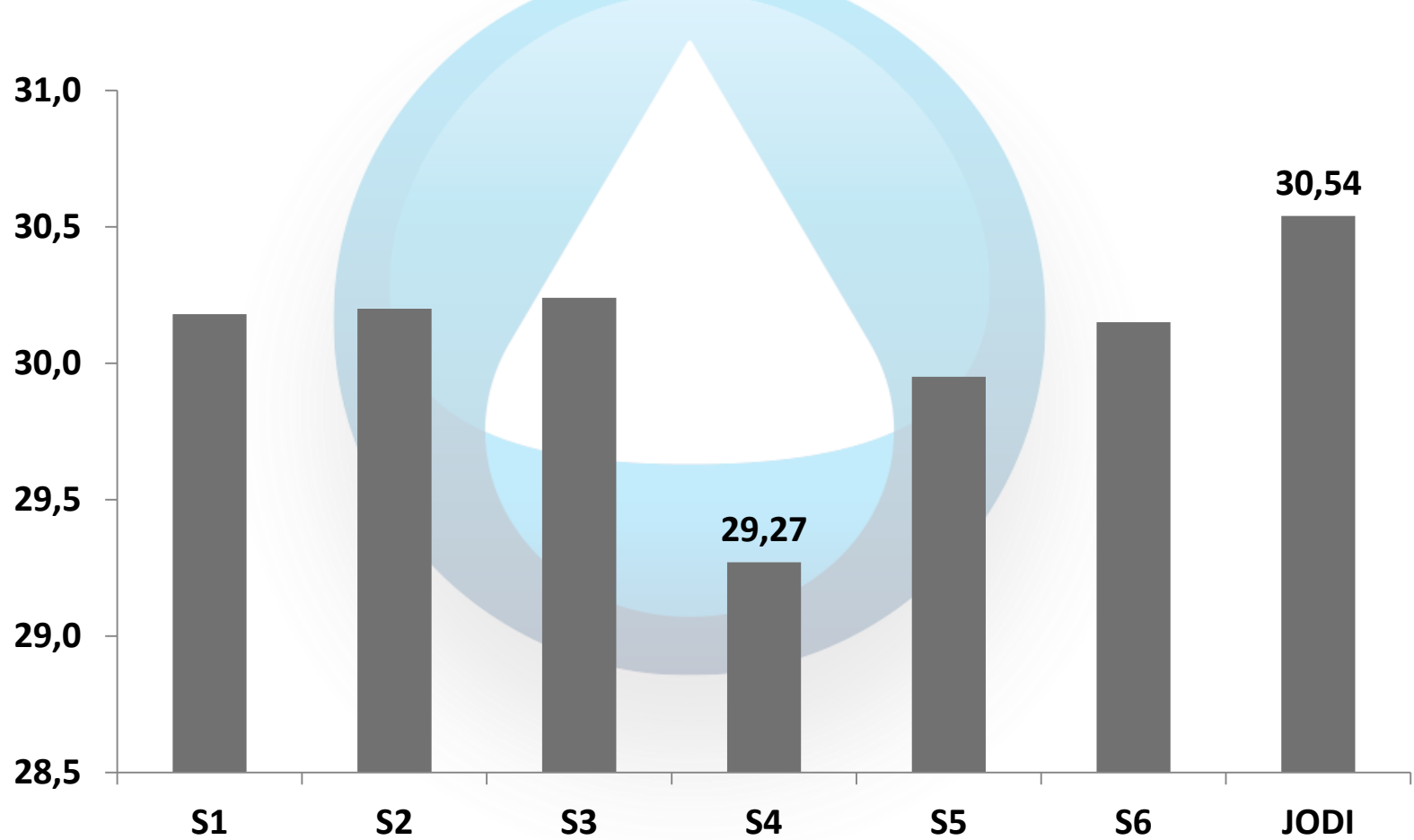   - Large variation in OPEC crude production among sources

Shortcomings of JODI oil data

Non-OPEC supply, *mb/d*

2013 revisions in reporting agencies using JODI oil data

Legend: OPEC, EIA, IEA

Discrepancies in reporting agencies using JODI oil data

OPEC: 54,2
EIA: 54,1
IEA: 54,6

A Concrete Outcome of the Consumer - Producer Dialogue

JOINT ORGANISATIONS DATA INITIATIVE

Shortcomings of JODI oil data

OPEC production: August 2014

Shortcomings of JODI oil data

- **Inventories**

  – Lack of major non-OECD countries' data (China, Russia)
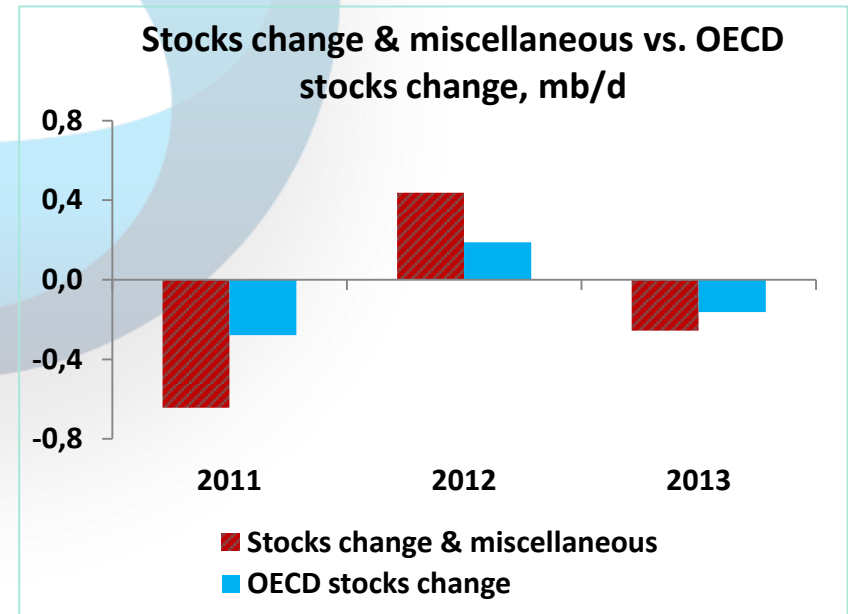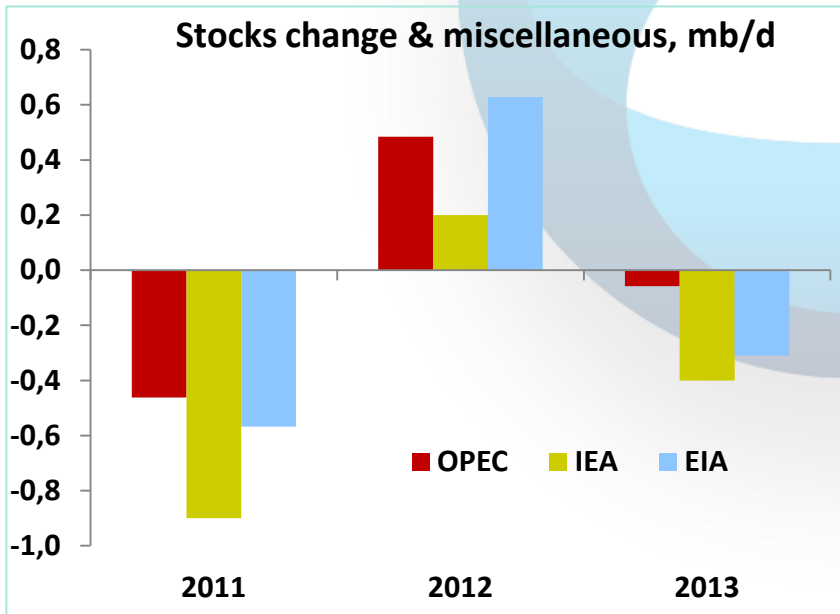
  – Inaccuracy of some non-OECD data (South Africa)

	3Q13	4Q13
Stock level (mb)	15	166
Days of cover	25	277

  – Discrepancy between global stock changes and balance
    (Supply - Demand)

Shortcomings of JODI oil data

- ## Inventories
  - Total oil stocks and supply/demand balance are interrelated through the following equation:

    - ### Change in total stocks = supply – demand

  - The global picture of stocks is the ultimate tool for checking the supply and demand numbers. However, the lack/inaccuracy of stocks data makes this difficult
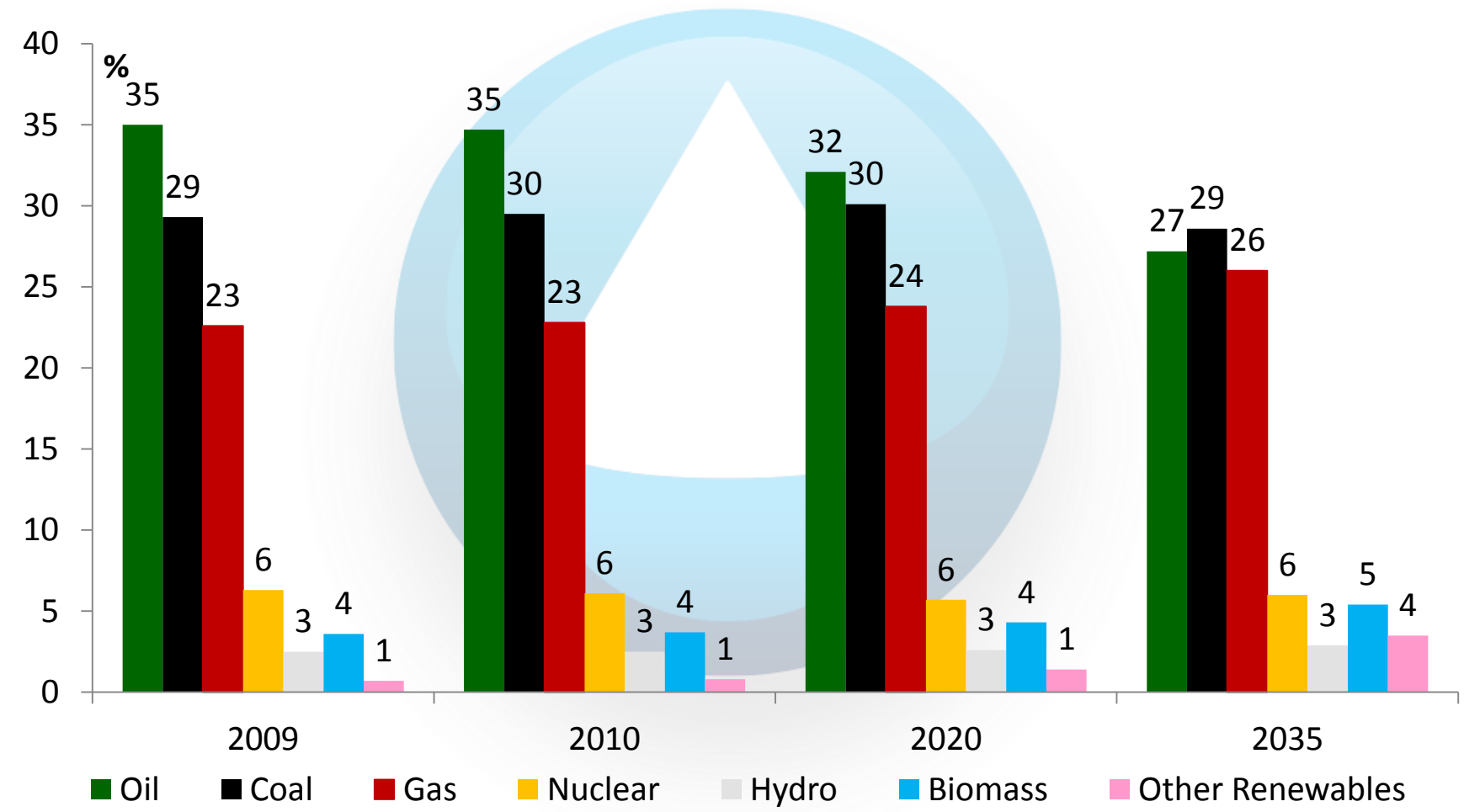

Stocks change & miscellaneous, mb/d

Legend: OPEC, IEA, EIA — years 2011, 2012, 2013

Stocks change & miscellaneous vs. OECD stocks change, mb/d

Legend: Stocks change & miscellaneous, OECD stocks change — years 2011, 2012, 2013

A Concrete Outcome of the Consumer - Producer Dialogue

JOINT ORGANISATIONS DATA INITIATIVE

Importance of JODI gas data

Why collect natural gas data

- Provide timely data on major flows, which are relevant to market
  - Production
  - Consumption
  - Storage
- Natural gas consumed to a large extent by households (~ 1/3)
- Seasonality in natural gas demand
- Natural gas demand weather dependent
- Swings in natural gas production
- Importance of natural gas storage as demand cannot absorb produced volumes throughout the year
- Natural gas as substitute for oil (fuel oil, gas/diesel oil)
  - US, Japan, India

Importance of natural gas data

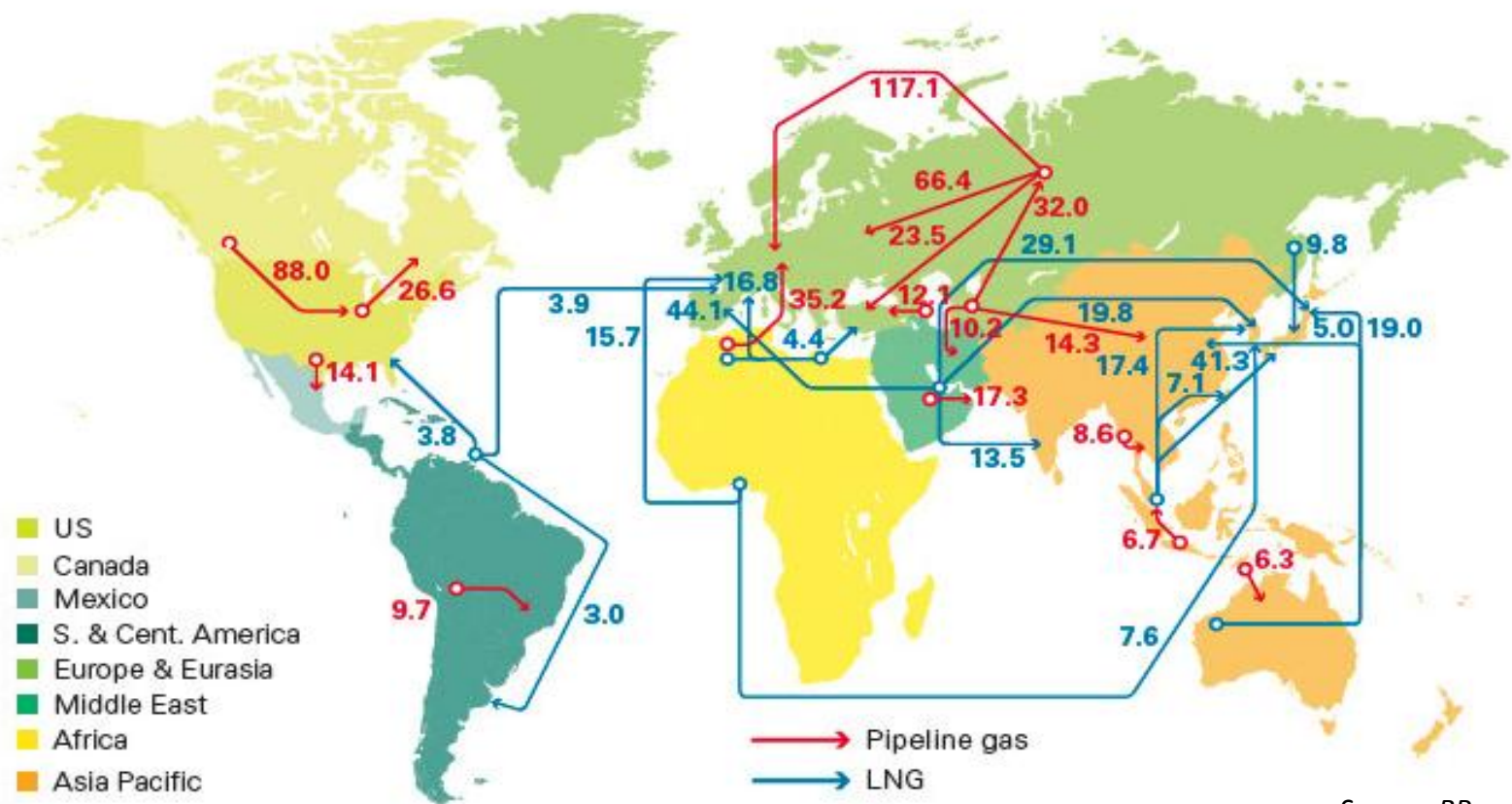- Natural gas importance to increase in future world energy demand mix

Chart: %

2009: Oil 35, Coal 29, Gas 23, Nuclear 6, Hydro 3, Biomass 4, Other Renewables 1

2010: Oil 35, Coal 30, Gas 23, Nuclear 6, Hydro 3, Biomass 4, Other Renewables 1

2020: Oil 32, Coal 30, Gas 24, Nuclear 6, Hydro 3, Biomass 4, Other Renewables 1

2035: Oil 27, Coal 29, Gas 26, Nuclear 6, Hydro 3, Biomass 5, Other Renewables 4

Legend: Oil | Coal | Gas | Nuclear | Hydro | Biomass | Other Renewables

Source: OPEC World Oil Outlook 2014

Importance of natural gas data

- Increasing trade worldwide

Major natural gas trade movements 2011
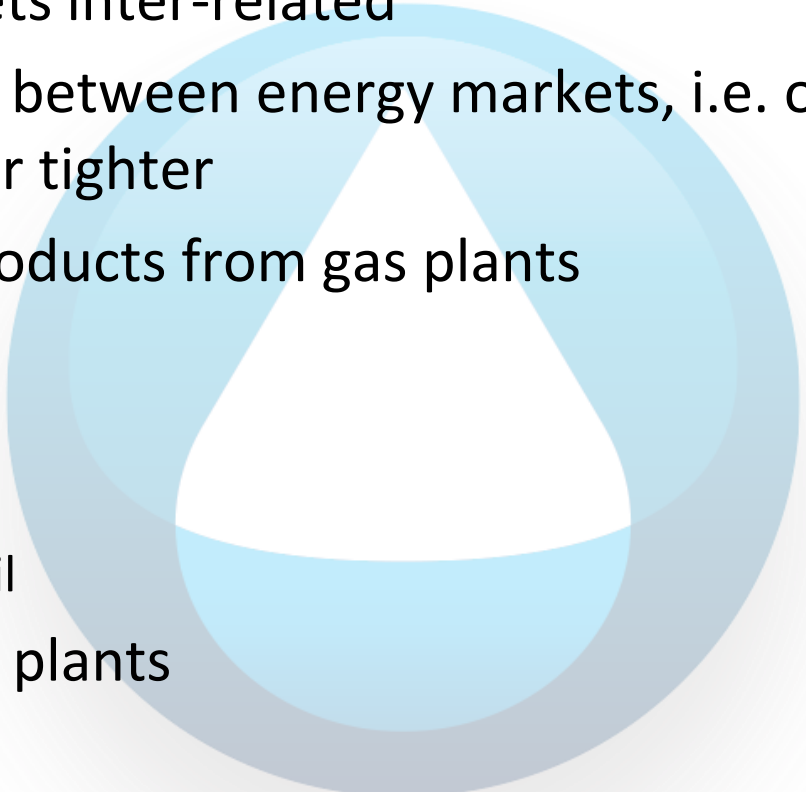### Trade flows worldwide, in billion cubic meters

Legend:
- US
- Canada
- Mexico
- S. & Cent. America
- Europe & Eurasia
- Middle East
- Africa
- Asia Pacific

→ Pipeline gas
→ LNG

Source: BP

Importance of natural gas data

- Natural gas trade movements in Europe

Source: Cedigaz
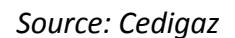
Relevance of natural gas data to oil market

- Energy markets inter-related

- Competitions between energy markets, i.e. oil, natural gas, coal and other tighter

- Petroleum products from gas plants
  - LPG
  - Gasoline
  - Naphtha
  - Gas diesel oil

- Gas to liquids plants

- Oil supply/demand balance being increasingly influenced by other primary commodities, most importantly gas
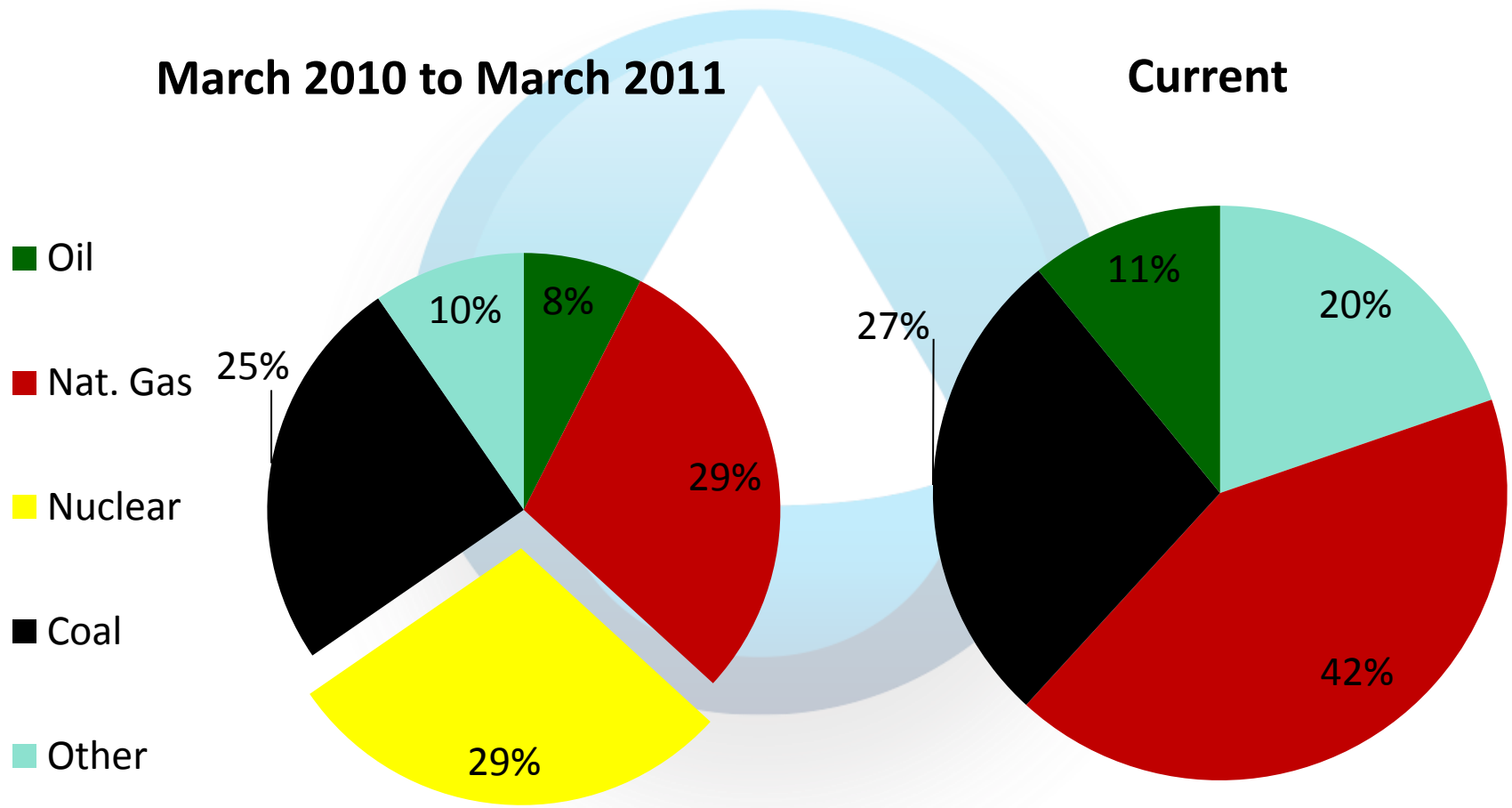
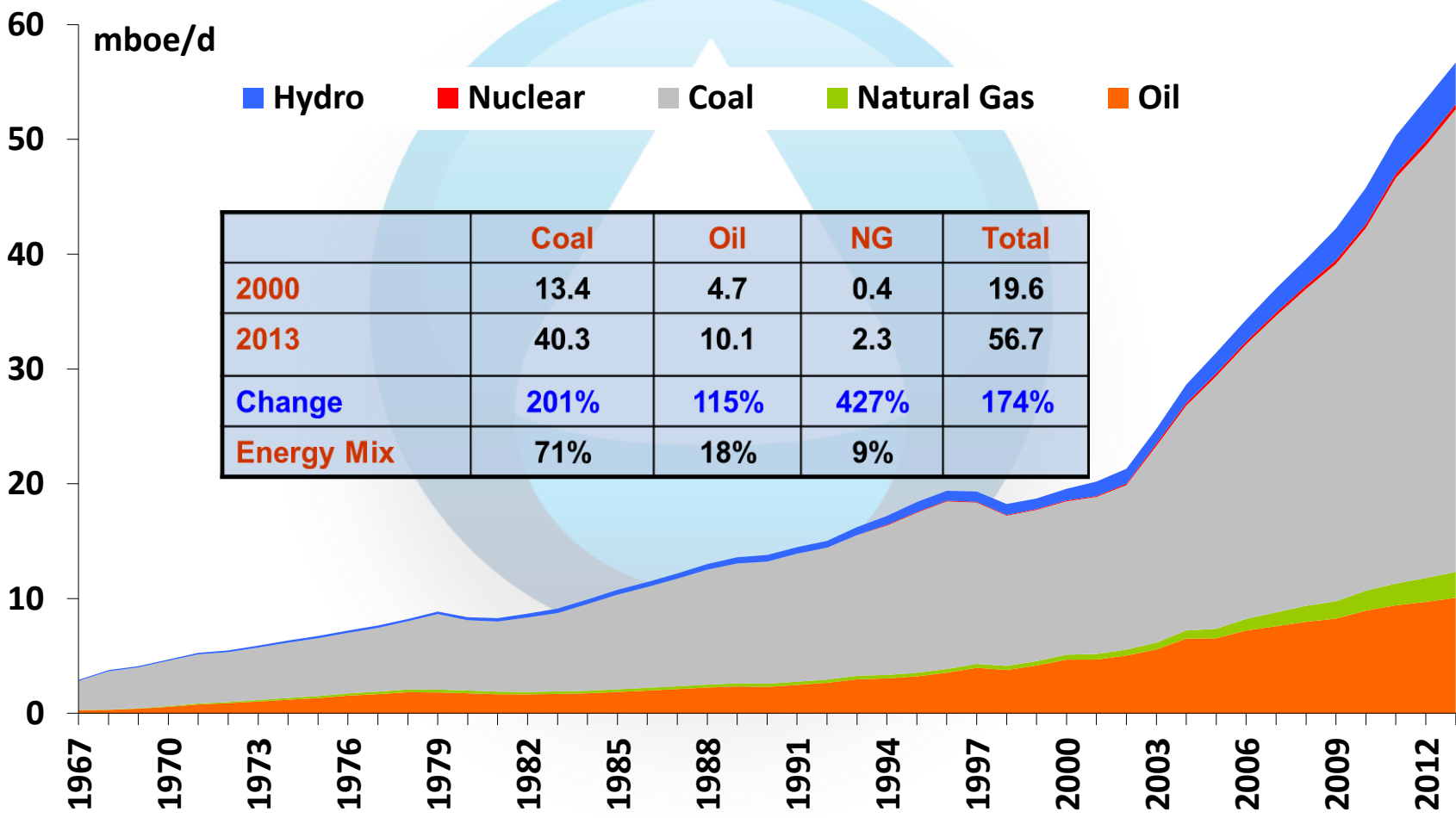# Relevance of natural gas data to oil market

- US shale gas production

billion cubic feet

Year	Production
2007	~1300
2008	~2100
2009	~3100
2010	~5350
2011	~8000
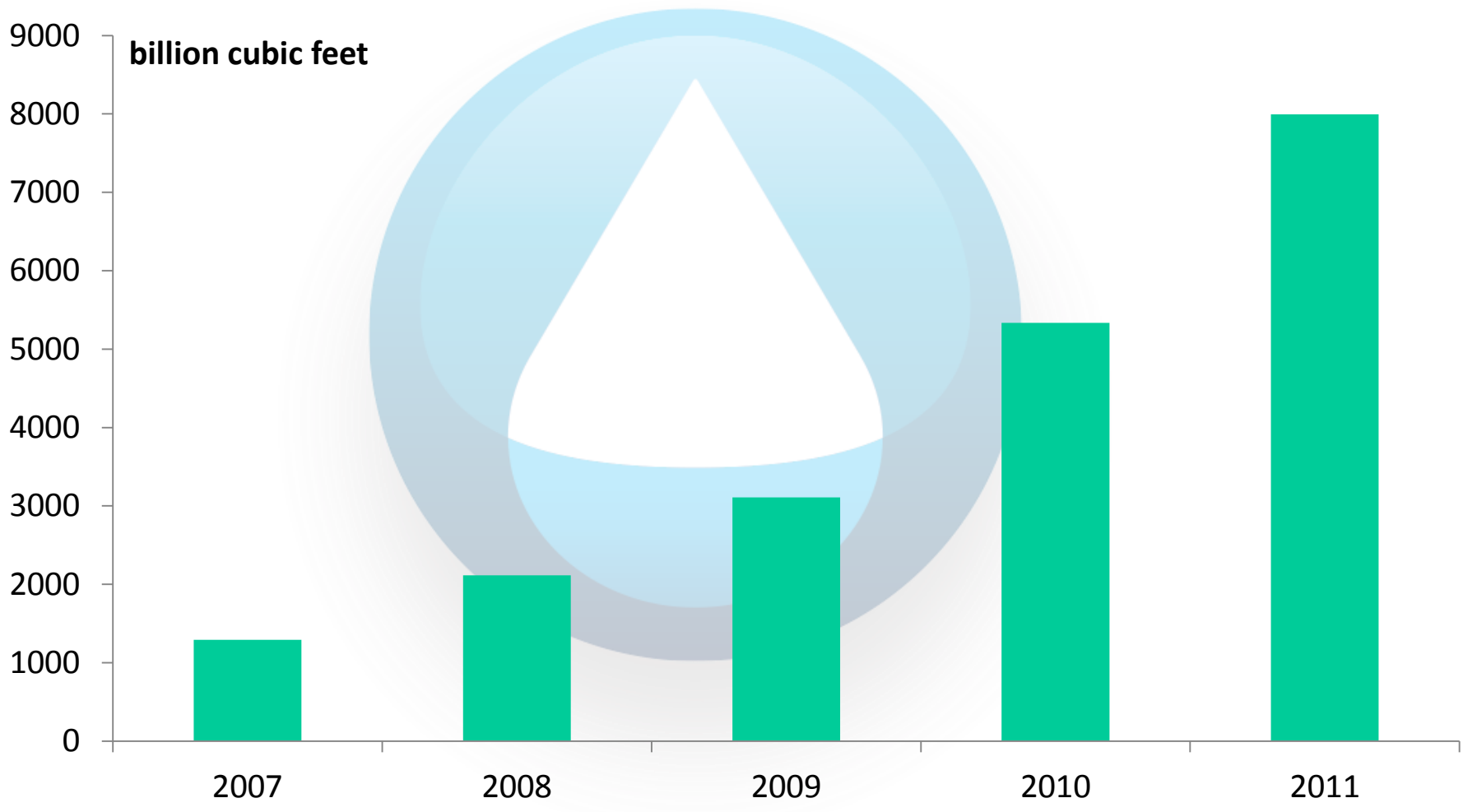
Source: EIA/DOE

Relevance of natural gas data to oil market
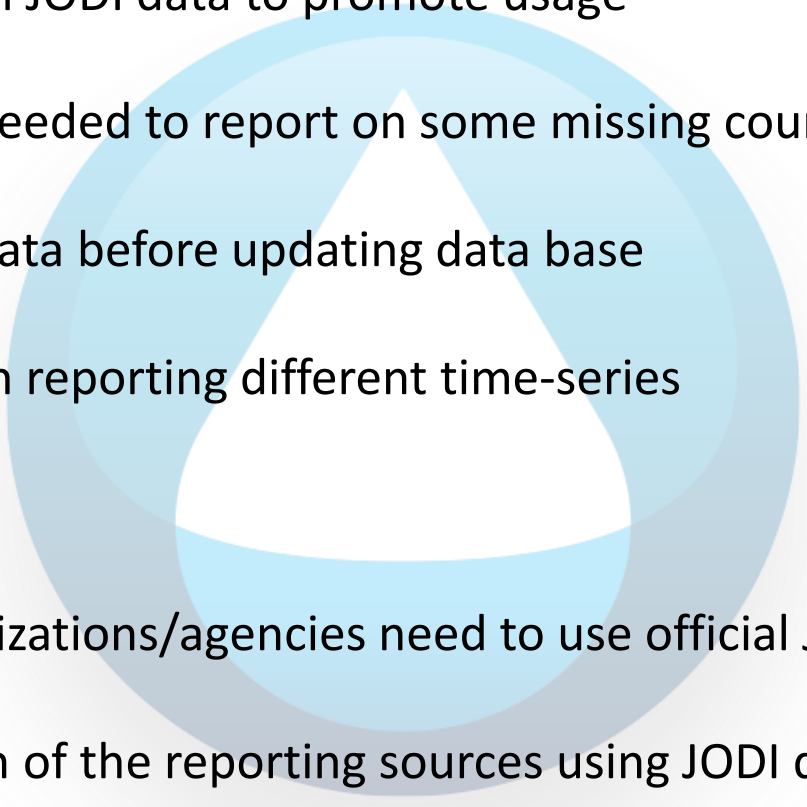
- Fuel substitution: Electricity generating fuels in Japan

March 2010 to March 2011

Current

■ Oil

■ Nat. Gas

■ Nuclear

■ Coal

■ Other

8%
10%
25%
29%
29%

11%
20%
27%
42%

Relevance of natural gas data to oil market

- Chinese energy demand mix

mboe/d

Legend: ■ Hydro ■ Nuclear ■ Coal ■ Natural Gas ■ Oil

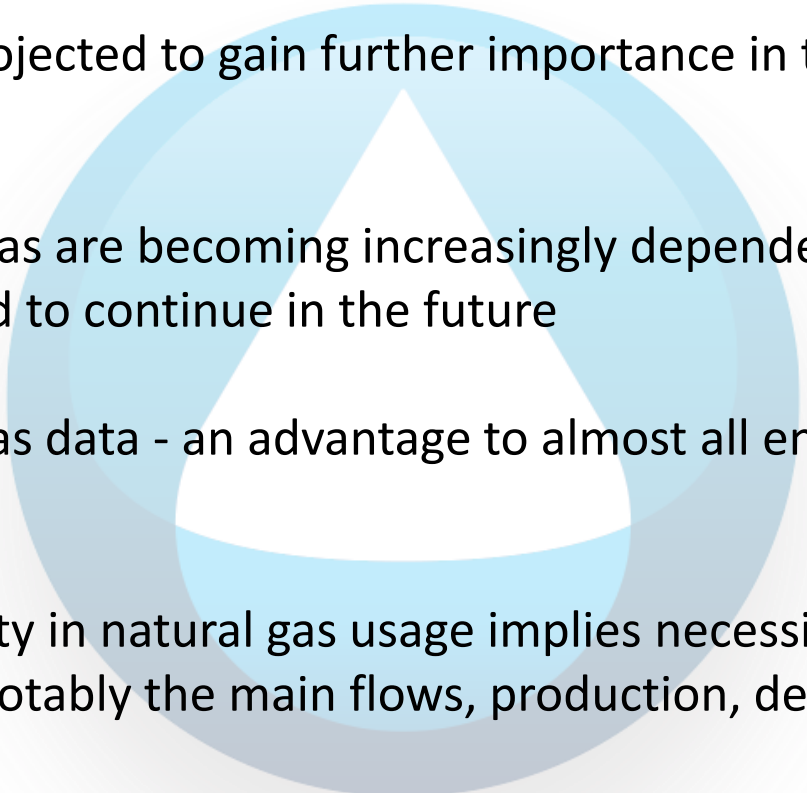|	Coal	Oil	NG	Total
2000	13.4	4.7	0.4	19.6
2013	40.3	10.1	2.3	56.7
Change	201%	115%	427%	174%
Energy Mix	71%	18%	9%	

Outlook and expectations

Oil data

- Improvements in JODI data to promote usage

  - More effort needed to report on some missing countries

  - Cross check data before updating data base

  - Consistency in reporting different time-series

- Reporting organizations/agencies need to use official JODI data

- Avoid estimation of the reporting sources using JODI data

- Reduce discrepancies between the reporting sources (0.5% ~ 0.5 mb/d)

Gas data

- Natural gas is projected to gain further importance in the world's energy mix

- Oil and natural gas are becoming increasingly dependent over time – trend is expected to continue in the future

- Timely natural gas data - an advantage to almost all energy related research

- Strong seasonality in natural gas usage implies necessity in collecting monthly data - notably the main flows, production, demand and storage

Thank you

For more information at
www.jodidata.org