Digitalization of production processes

It is essential for the Company to incorporate the advantages that technological progress has given us. To this end, the Company responds to the realities of the times and uses the best global practices to improve business efficiency.

In 2020, more than 30 projects were launched as part of digital transformation programs.

The highest priority areas for the Company are the development and introduction of machine-learning technologies, big data processing, artificial intelligence, and software robotics.

The development of digital technologies creates new opportunities for oil and gas production processes, from the ability to remotely control processes and objects to the creation of high-precision simulators for the modeling of physical and chemical processes under given temperature and pressure conditions.

In an attempt to practically apply these opportunities, the following key digital projects with a technological focus are being implemented as part of the Company's Digital Transformation Program:

- Digital Field project
- Digital Core project

DIGITALIZATION OF PRODUCTION PROCESSES

Project

Digital field

Implementation of the complex Digital Field project — a powerful driver for increasing development efficiency

Remote, complex fields can be successfully developed using real-time management methods and technologies, modeling tools and decision support when there is risk and uncertainty.

In this regard, the implementation of the Digital Field project is a powerful driver for improving development efficiency, as it enables remote online management of production facilities, while significantly reducing production costs and increasing operational safety.

> *Reducing the time that people are physically present at production sites has become even more important given the pandemic. The ability to remotely monitor and control the production process is one of the key goals of the Digital Field.*

Remote control

online operation of production facilities

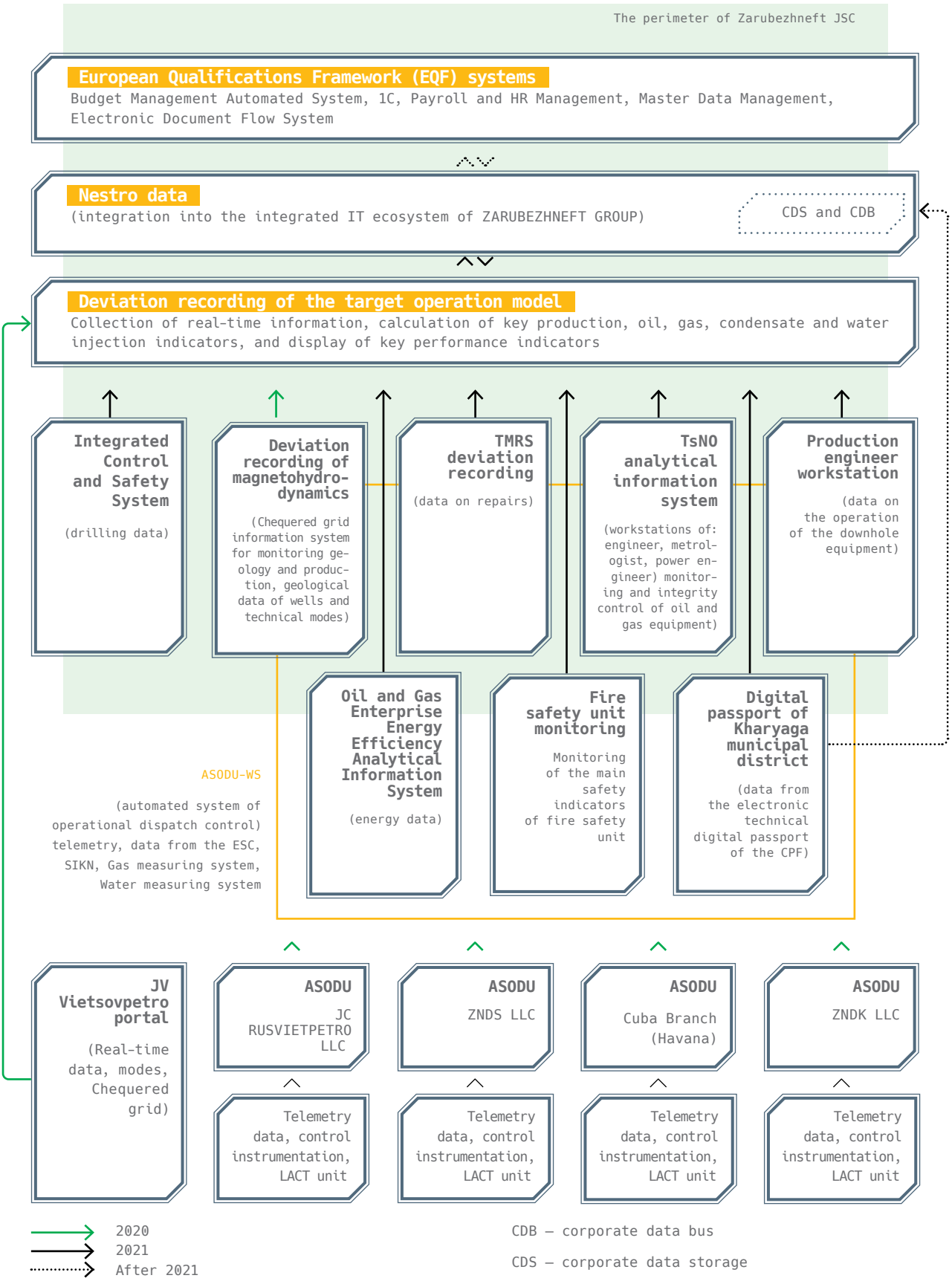
Creation of high-precision simulators

to simulate physical and chemical processes

Decrease in production expenses

and increase in operating safety levels

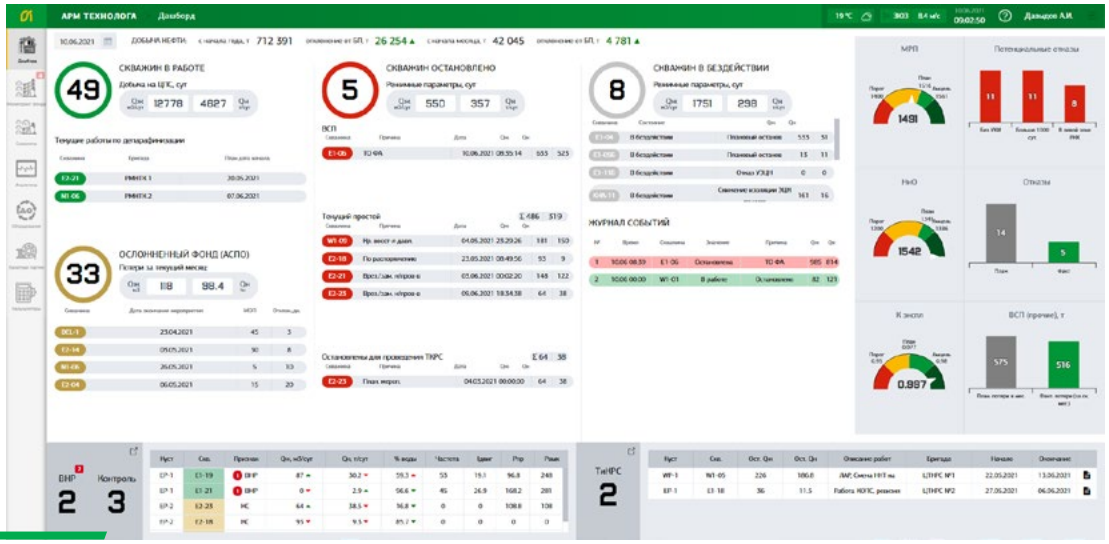
CONCEPUTAL FLOW CHART



Telemetry data is obtained from oilfield production facilities through an automated dispatch control system (ADCS), which uploads process data on the operation of facilities at Zarubezhneft fields to higher-level systems for the adoption of the management decisions presented below.

1. **The Real-time Monitoring Center Information System (RMC IS).** The key higher-level system that aggregates all production indicators at Zarubezhneft is the Real-time Monitoring Center information system, which ensures the calculation of key indicators of ZARUBEZHNEFT GROUP's subsidiaries, the display of these indicators, and the automated generation of reports.
2. **The Oil and Gas Field Equipment Integrity Automated Information System** controls and monitors oil and gas equipment, certifies supervisory equipment, oversees accounting, the correct and safe operation of oil field equipment, and the planning and control of maintenance and repair activities, and predicts equipment failure time (predictive analytics) in the following areas: Mechanics, Power Engineering, Metrology, and Control Instrumentation.
3. **The Production Engineer Automated Workstation (AWS)** performs real-time control and monitoring of the condition of the power-operated well stock, calculates the flow and pressure indicators of pumps, generates a preventive maintenance schedule, predicts the movement of crews, and maintains a database of manufacturer's certificates for submersible equipment.
4. **The Automated Energy Efficiency System (AEES)** monitors the state of the energy system, simulates the electric grid, and assesses the energy efficiency of technological processes and the operation of pumping equipment.
5. **The digital passport of the Kharyaga oilfield** is a paperless technical data sheet of the Central Gathering Facility of the Kharyaga oilfield. The passport is a joint information center for obtaining data on design, working, engineering, and as-built documentation, which can be accessed from a 3D model of the object with a high degree of detail. The digital passport can display 3D and VR models of the Kharyaga oilfield's Central Production Facility. It also includes Virtual Reality and Personnel Training Simulator modules. The digital twin of the Kharyaga oilfield is a unique development that has no counterparts in the industry.
6. **The hazardous production facility monitoring information system** performs real-time assessments of the condition of hazardous production facilities in hazard classes I and II that are listed in the state register, including monitoring of current technological parameters affecting industrial safety, an analysis of the overall state of industrial safety, and the prediction of emergency situations.
7. **The routine repair and well reconstruction information system** helps to plan repair work, ensure real-time accounting and monitoring of the parameters of operations, draft regulatory reporting, analyze work efficiency, and compile a database and electronic dossier of wells.
8. **The drilling management information system** ensures real-time and strategic planning, the prompt provision of complete and reliable information to all levels of management about work, research, costs, and operative solutions to geological and technological problems.

Production engineer workstation



OPERATIONAL MONITORING CENTER

Digital Field

The key higher-level system that aggregates all production indicators at Zarubezhneft JSC

It ensures the calculation of key indicators of ZARUBEZHNEFT JSC Group's subsidiaries, the display of these indicators, and the automated generation of reports.

Implemented system modules:

- Operative 2-hour
- Material balances
- Statements
- General display

PRODUCTION ENGINEER WORKSTATION

Digital Field

performs real-time control and monitoring of the condition of the power-operated well stock, calculates the flow and pressure indicators of pumps, generates a preventive maintenance schedule, predicts the movement of crews, and maintains a database of manufacturer's certificates for submersible equipment

5 *developed modules*

+70%

available time

DIGITAL PASSPORT OF THE KHARYAGA OILFIELD

Digital Field

The Digital Technical Passport of the Kharyaga Oil Field Central Processing Facility is a joint information center for obtaining data on design, working, engineering, and as-built documentation, which can be accessed from a 3D model of the object with a high degree of detail.

The digital twin of the Kharyaga oilfield

is a unique development
that has no counterparts in the industry.

TOTAL

rated this project as a model one.

The biggest significant effect has been achieved by introducing a comprehensive development system that ensures the sound management of the development, planning, and implementation of measures to increase the degree of oil reserves recovery.

DIGITALIZATION OF PRODUCTION PROCESSES

The Company seeks to achieve a real practical effect from digitalizing the production processes of its assets. In the near future, the Company plans to continue the development of the Digital Core project.

Project

Digital Core

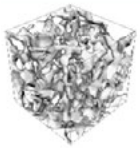
At the hydrophobic fractured reservoirs of ZARUBEZHNEFT GROUP's fields, some of the most urgent issues are the reliable identification of filtration features for the analysis of water-flooding conditions and selection of chemical and physical injection media to increase oil recovery.

The solution is to create approaches and tools for the analysis and modeling of processes at a micro-level (core scale), with the subsequent application of results using standard tools at a macro-analysis level (field scale).

In 2020, VNIIneft JSC and Kazan Federal University (KFU) created a prototype for calculating dual-phase immiscible flows. In 2021, the prototype model is expected to be conveyed to the engineering tool. In addition, the foundations were laid in 2020 for the creation of a new theory for modeling compositional flows on a pore scale.

Goal

Reliable field-scale simulation of EORM using available hydrodynamic simulators



Core

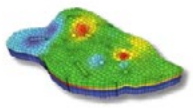
Transferred parameters:

- Physical and chemical interaction parameters
- Statistical parameters of void space and geometry

Representative volume element

Transferred parameters:

- Pc
- Single-phase flow
- Sor, Swcr
- Permeability and porosity tensors



Full-scale model of the object

MICRO-scale → MESO-scale → MACRO-scale

Physical and chemical core simulator	Meso-level simulator	Full-scale simulator
	(calculation simplification for an acceptable loss of accuracy)	(Eclipse, CMG)

The project focuses on developing a set of experimental and computational tools to study oil and gas reservoir rocks in order to:

- Enhance the speed and reliability of determining properties
- Minimize the time and expenses for the selection of EORM agents
- Ensure the correct transition from core scale to hydrodynamic model scale
- Reduce uncertainties in the appraisal of new projects
- Solve the problem of core material preservation

The ability to introduce Digital Core technology to replace traditional core studies is a breakthrough, fundamental step in improving the efficiency of EORM selection and design process, which ensures:

- A multi-fold increase in the efficiency of the selection and application of tertiary enhanced oil recovery methods
- A reduction in the cost of EORM selection and the time required to fulfill a pilot project
- An increase in the success of projects that use EORM