Economy-wide Effects of Climate Change and Adaptation in the Energy Sector of Kazakhstan

Anett Großmann (GWS) | 18 May 2022

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

In cooperation with:

ECONOMIC RESEARCH INSTITUTE

GWS SPECIALISTS IN EMPIRICAL ECONOMIC RESEARCH

A global programme in 3 countries – Climate Resilient Economic Development (CRED)

In the frame of the International Climate Initiative (IKI)

IKI INTERNATIONAL CLIMATE INITIATIVE

Beneficiary: Economics/planning ministries in the three pilot countries: Kazakhstan, Georgia, Vietnam

Funder: Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU)

Duration: 01/01/2019 - 31/12/2022, ext. 03/2023

Budget: 4,000,000 EUR

Programme Overview

Country	Kazakhstan	Georgia	Vietnam
Political Partner	Ministry of National Economy (MNE)	Ministry of Economy and Sustainable Development (MoESD)	Ministry of Planning and Investment (MPI)
Implementation Partner	Institute of Economic Research (ERI)	MoESD Sustainable Development Division	Central Institute for Economic Management (CIEM)
Model	e3.kz Model Dynamic input-output-model	e3.ge Model Dynamic input-output-model	DGE-CRED Model Dynamic general equilibrium model
Software	Excel, R	Excel, EViews	Matlab, Dynare
Consultancy	GWS SPECIALISTS IN EMPIRICAL ECONOMIC RESEARCH	GWS SPECIALISTS IN EMPIRICAL ECONOMIC RESEARCH	IWH Halle Institute for Economic Research Member of the Leibniz Association

CRED Approach | Methods for assessing and planning climate resilient economic development

Getting ready for Climate Risk Management

- Creating high-level political support for economic evaluation of adaptation options
- Assessing climate impacts and risks
- Identification of main adaptation concerns to be evaluated

Modelling & Evaluation of Adaptation

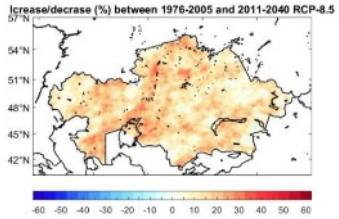
- Building a macroeconomic model reflecting the long-term development of the national economy
- Scenario analysis of GDP and employment effects of adaptation at national level

Enabling Climate Resilient Development

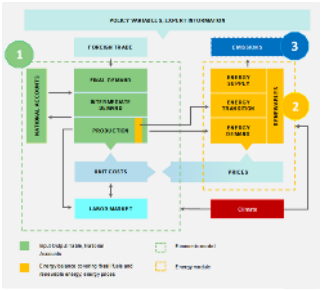
- Creating the basis for selection of adaptation measures in NAP process or sectoral planning
- Mainstreaming adaptation into development strategies/ budgeting decisions
- Providing economic framework for monitoring and evaluation of adaptation

CRED Kazakhstan Process | Macroeconomic Modelling for Evidence-based Policymaking

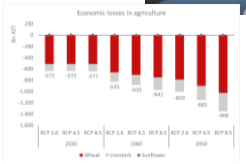
- Collection of economic and climate data



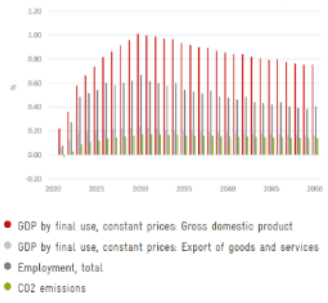
- Set up country-specific E3 model



- Select sectors
- Select climate hazards (intensity & frequency)
- Estimate damage costs
- Model climate adaptation options



- Sector-specific & economy-wide effects (GDP, jobs, CO2 etc.)
- Direct and indirect effects



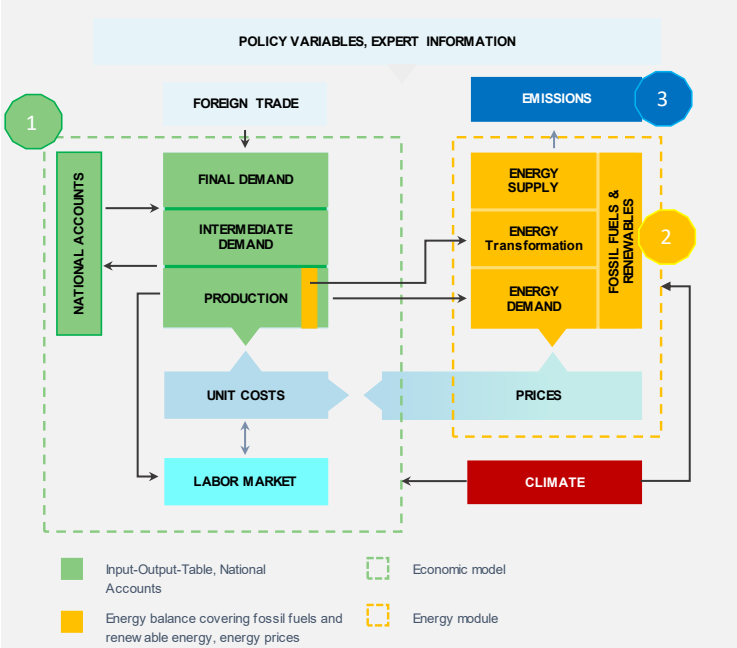
- Feed results into policy process and stakeholder discussions
- Further analyse and prioritize adaptation options
- Discuss financing options

Data → **Model** → **Scenario Analysis** → **Results** → **Recommen-dations**

The E3.kz Model | A Dynamic Input-Output Model for Kazakhstan

- Economic model extended by environmental aspects (E3 – **e**conomy, **e**nergy, **e**missions)
- Based on **country-specific, official data**
- Model relationships are deterministic and econometrically estimated (estimations are done in “R”)
- **Excel-based** modeling framework (model equations are programmed in Visual Basic for Applications)
- Mid- to long-term perspective (until 2050)
- Suitable for **scenario analysis** (“what-if”)
  - CRED focusses on climate change adaptation scenarios
  - Scenario analysis is used to implement sector-specific climate impacts and adaptation measures
  - Model results show the direct, indirect and induced macroeconomic impacts (GDP, imports, sector-specific production and employment)

- E3.kz can be also used for other scenario analyses, e.g., macroeconomic impacts of **mitigation** measures

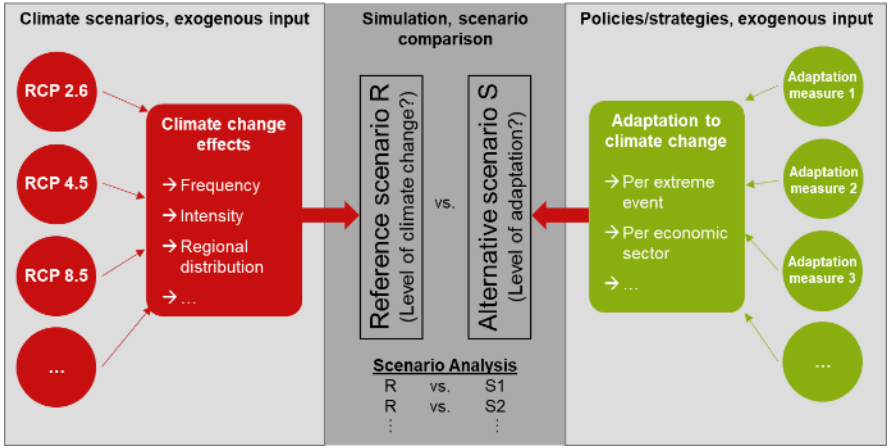


Source: Großmann et al. 2022, based on GWS 2022

Climate Change Adaptation Scenarios as „What-if“ Analysis

Main prerequisites

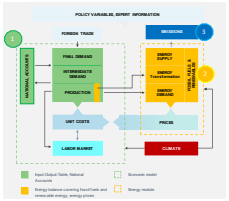
- **Climate scenario** with a regional breakdown and future evolution of climate hazards
- Identification of relevant interfaces and **effect chains of climate hazards**
- **Sector-specific**, quantified **damage data**
- **Cost-benefit-analyses** of sector-specific **adaptation measures**



Benefits of e3.kz

- Model shows **macroeconomic results** and **inter-sectoral effects** in the **medium to long term**
- The **macroeconomic implications of climate hazards** can be estimated
- Adaptation options can be evaluated against each other to **find favorable solutions**
- E3.kz covers the linkages between the 3E’s and enables to **detect synergies and trade-offs** of policy measures

Effects are translated into E3.kz model variables



Climate Change Impacts on the Energy Sector

- Climate change (CC)…
  - **Impairs energy production**: e.g., lower power production due to insufficient cooling and lower water level
  - **Impacts energy demand**: e.g., increased demand for air conditioning
  - **Destroys energy infrastructure**: e.g., damages oil pipelines, eroded power lines
    - ➢ **Infrastructure suffers from *direct* physical CC impacts** and **businesses suffer from *indirect* losses** caused by disruption of transportation and energy supply (OECD 2018, World Bank enterprise surveys 2019)

- Adaptation to CC
  - Construction and regular maintenance of infrastructure offers the opportunity to adapt to CC in advance (**proactive** adaptation)
  - Build-back better (**reactive** adaptation) after experiencing CC impacts
  - Deployment of win-win solutions for adaptation and mitigation, E.g., **water-independent energy sources** and **improvement of energy efficiency improvements**

https://earth.stanford.edu/news/droughts-boost-emissions-hydropower-dries#gs.2hfgak

Collecting damage data: Impact of heat waves in Kazakhstan

Sector	Impact	Source
	Increased government expenditures for health care services due to heat stress (+0.3%)	Own assumption based on estimations for Germany (Hübler 2014)
	Increased demand for beverages due to heat (+3%)	Own assumption based on Mirasgedis et al. 2014 and experiences in Germany during a heat wave in 2018
	Higher electricity demand for cooling (+6%)	Own assumption based on experiences in Germany
	Decreased hydro power production due to lower water levels caused by higher evaporation (-20%)	IEA energy balance 1998
	Reduced thermoelectric power potential due to insufficient cooling (-4%)	Van Vliet et al. 2016

Source: Großmann et al. 2022

Example: Macroeconomic Impacts of Heatwaves on Energy Sector without Adaptation

- **Lower real GDP growth path**
  - **Constrained** hydro and thermoelectric **power production**
  - Increased electricity demand for cooling satisfied by **increasing power imports**

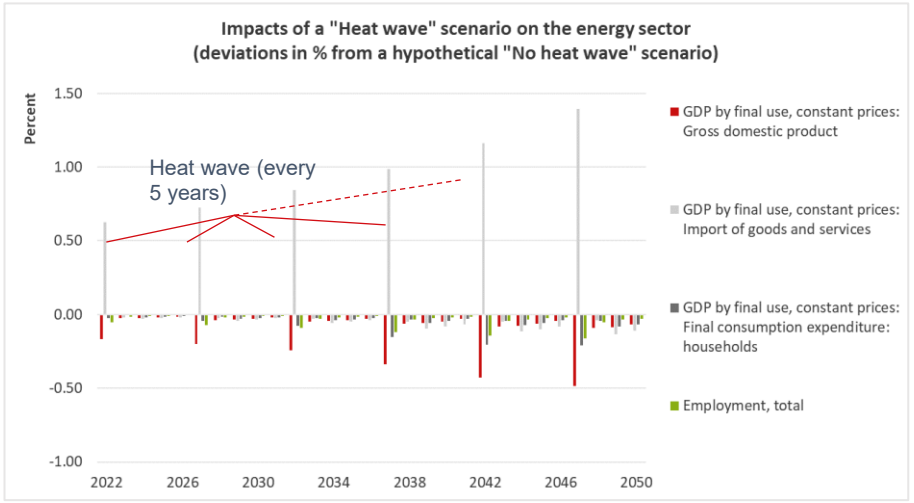
➢ **CO2 emissions** in energy industries are at a **lower** level.
If the imported electricity is generated from renewable energy, the environmental effects are positive.

- **Lower employment and income** reduce spending opportunities of private households.

- Economy partially recovers between heat wave years

➢ **With more heatwaves, energy security might be at risk.**

➢ **Climate change endangers jobs and income not only in the energy sector.**



Source: Großmann et al. 2022

Climate Change Adaptation Measures in Energy Sector

Example: Heat wave and deployment of wind power and energy efficiency improvements in the housing sector in Kazakhstan

Costs and benefits derived from sector-specific analyses and expert knowledge

Adaptation measures	Cumulated investment (2022-2050)	Adaptation benefits (by 2050)
Deployment of wind power[1]	• 2.9 trillion KZT* (2.8 GW additional installed capacity at 2,472 USD / kW) • Capacity factor: 36 % à 8,831 GWh	• Preservation of power generating capacity during heat waves
Energy efficiency improvements in housing[2, 3]	• 9 billion USD	• Reduced energy demand by -11% for housing compared to BAU in 2050

Source 1 IRENA., 2021; 2 World Bank, 2018b; 3 LEDS table 13 and table 20

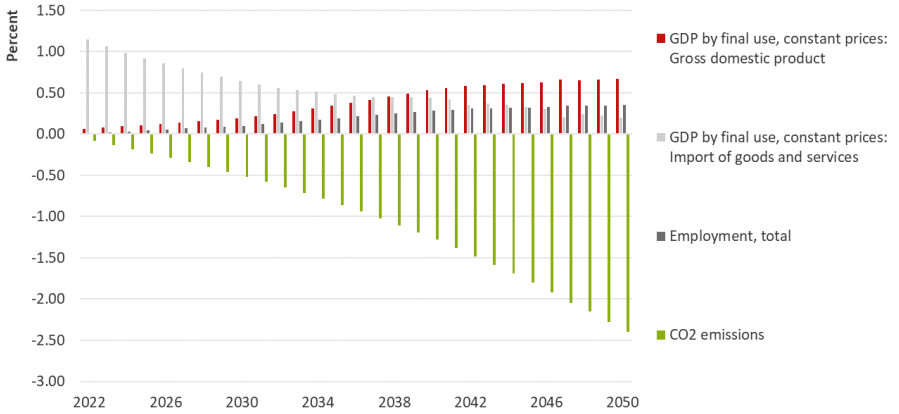
Adaptation costs ↑

Climate change damages ↓

Macroeconomic Impacts of Heatwaves on Energy Sector with Adaptation Action

Example: Heat wave and deployment of wind power and energy efficiency improvements in the housing sector

- **Higher GDP** (up to 0.7% p.a. or 558 bn. Tenge) compared to the heat wave scenario
  - **Refurbishment** of houses **stimulates construction activity** and **lowers energy demand**
  - **Increased imports** of wind turbines
  - **Higher employment** (up to 35,000 additional jobs or 0.35% p.a.) and income
- **CO2 emissions are rising slower** compared to a heat wave scenario without adaptation resulting in up to -2.4% per year despite higher economic activity.



Conclusions

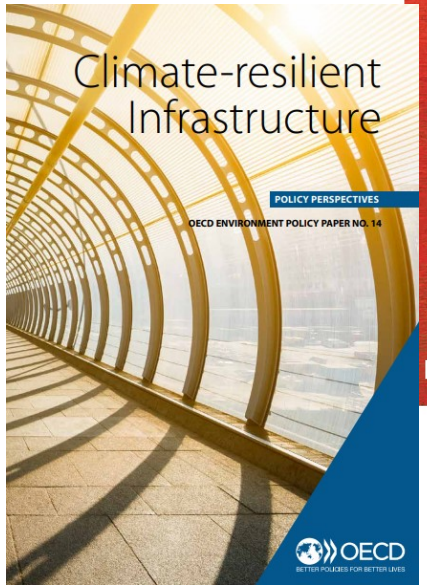
- Adaptation improves energy security and provides co-benefits (reduces economic losses, creates jobs, increases GDP)
- Additional imports curtail the advantages. Imports would be better replaced by domestic production.
- Combining climate protection and adaptation measures can create co-benefits.
- International funding opportunities should be explored to allow for even better macroeconomic impacts

Increasing the Resilience of the Energy System

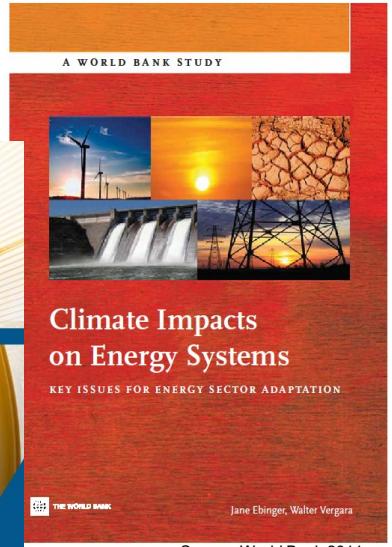
- **Structural adaptation measures**
  - Protective dams for critical infrastructure
  - Improve robustness of installations, pipelines and other infrastructure, e.g. **underground or insulated power lines**
  - Additional and larger reservoirs
  - Investment in high-efficiency infrastructure and renewable energy
  - …

- **Management (or non-structural) adaptation measures,** e. g.
  - Enhanced monitoring of assets to reduce the risk of failure
  - Changing the timing of maintenance to account for changing patterns of energy demand and supply
  - …

Source: OECD 2018, World Bank 2011



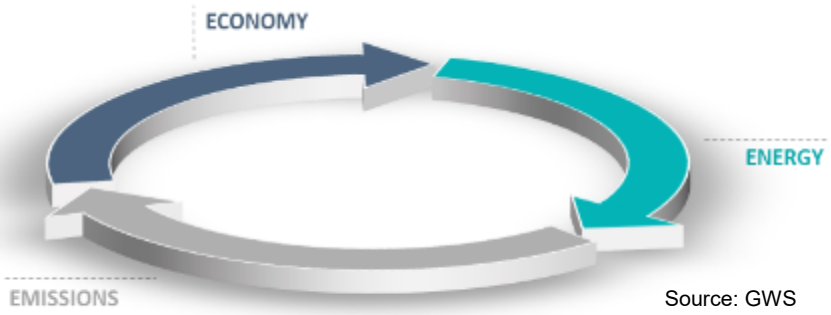
Source: OECD 2018



Source: World Bank 2011

E3 model prototype facilitates transfer of CRED approach to other countries

- E3 model prototype based on **international data** (OECD/ADB, IEA) serves as a show case without reinventing the wheel
- E3 model prototype supports the **international exchange** between institutions, governments and other actors **and** allows **comparison**
- **Virtual teaser training** to be offered to other countries in second half of 2022



Source: GWS

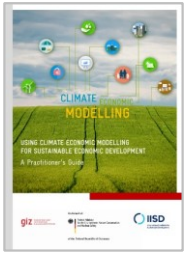
Dissemination | Overview of knowledge products

Climate hazard analyses Georgia and Kazakhstan

Model Handbooks Georgia, Kazakhstan and Vietnam

Global + National Modelling Reports

Climate Economic Modelling. A Practitioner's Guide



Preparation

Factsheet

Project Brief: Managing Economic Risks of Climate Change

Modelling & evaluation

Model Comparison Study

Sectoral Policy Briefs and Infographics in Georgia and Kazakhstan

GEO: Agriculture, Tourism & Infrastructure
KAZ: Agriculture, Energy, Infrastructure
VN: Overall Economy, Agriculture

Implementation

Brief on Macroeconomic Modelling for Climate Resilience

Country Policy Reports in Georgia, Kazakhstan and Vietnam

See CRED project website for access to publications

Questions & Answers

Any questions or comments?

References

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