SHAPE

Sustainable development pathways achieving Human well-being while safeguarding the climate And Planet Earth

Fact Sheet:

Models used in SHAPE: IAM and Input-Output models

The SHAPE Sustainable Development Pathways (SDP scenarios) address the Sustainable Development Goals (SDGs) of the UN Agenda 2030 and climate change mitigation in an integrated way. They are quantified using different integrated assessment models (IAMs), as well as one input-output model. This allows for a model comparison approach to assess which indicator developments are "robust" (meaning that models show similar results), and where there is larger uncertainty about specific developments (the results are very different between models).

The models, however, differ in the way they calculate their results. While not every model can quantify the exact same indicators, a core set of indicators is common to them. A strength of the modeling as done in the SHAPE project is that sectoral input-output models provide detailed information about material flows that are taken up by the larger and less detailed IAMs. Together, the models allow for a more comprehensive analysis of the SDP scenarios, and hence of interactions between the SDGs and climate change mitigation. An overview of the models used for the analysis of the SDP scenarios is presented in the following, along with an overview of SDG indicators and how they are covered in the different models.

THE MODELS USED IN THE SHAPE PROJECT

➢ **MODEL TYPE**	**Integrated Assessment Models (IAM)**			**Input-Output model**
➢ **MODEL NAME**	**REMIND-MAgPIE**	**IMAGE**	**MESSAGEix-Buildings**	**EXIOfuture+ ODYM-RECC**
➢ **WEBSITE**	PIK	PBL	IIASA	NTNU
➢ **SHORT DESCRIPTION**	Modelling energy-economy & land use; transformation towards climate and sustainability targets	Biophysical & economic representation of the interactions between human and natural systems	Modelling energy and material demands, decent living conditions, and emissions from buildings	Tracking archetypes of demands: • Quantify material usage • Recycling • Environmental impacts ***Used to better define input for IAM models***
➢ **SECTORS**	• Macro-economy • Energy system • Land use • Climate	• Energy & land system • Agricultural economy • Climate	• Residential and commercial buildings	Input-output scenario and material flow models for the building sector & passenger vehicle
➢ **SPATIAL COVERAGE**	Global, regional (12 world regions)	Global, regional (26 world regions)	Global, regional	Global, regional

SELECTED SDG INDICATORS AND THEIR COVERAGE IN SHAPE's MODELS

SDG	Indicator	REMIND-MAgPIE	IMAGE	MESSAGEix-Buildings	EXIOfuture+ ODYM-RECC
SDG 1 NO POVERTY	Population living in (extreme) poverty (poverty lines at $1.90/day, $3.20/day, $5.50/day) *Note: A key assumption of the SHAPE SDP scenarios is the rapid reduction of inequality to meet poverty eradication targets.*	☑	☒	☒	☒
SDG 2 ZERO HUNGER	Population at risk of hunger	☑	☑	☒	☒
	Food availability	☑	☑	☒	☒
	Food price	☑	☑	☒	☒
SDG 3 GOOD HEALTH & WELL-BEING	Ambient air pollution: Premature deaths & life years lost	☑	☒	☒	☒
	Indoor air pollution: Child mortality	☒	☑	☒	☒
SDG 4 QUALITY EDUCATION	*Note: This SDG is covered as part of the SDP scenario assumptions used by all models. It is covered through the population projections (based on SSP1)[1].*	–	–	–	–
SDG 5 GENDER EQUALITY	*Note: This SDG is covered as part of the SDP scenario assumptions used by all models. It is covered by "gender equality in education" as part of the population projections (based on SSP1).*	–	–	–	--
SDG 6 CLEAN WATER & SANITATION	Total water withdrawal	☒	☑	☒	☒
	Nitrogen surplus on cropland	☑	☑	☒	☒
SDG 7 AFFORDABLE & CLEAN ENERGY	Population with access to electricity	☒	☑	☑	☒
	Population with access to clean cooking	☒	☑	☑	☒
	Final energy use per capita	☑	☑	(☑)	(☑)
	Share of electrified final energy	☑	☑	(☑)	☒
SDG 8 DECENT WORK & ECONOMIC GROWTH	Growth rate GDP per capita (PPP) *Note: GDP scenarios are part of the SDP assumption set and are harmonized between all models.*	☑	☑	☑	(☑)
	Ratio of GDP per capita (PPP) of developing regions to OECD average	☑	☑	☑	(☑)
SDG 9 INDUSTRY, INNOVATION & INFRASTRUCTURE	CO_2 emissions from industrial processes	☑	☑	☒	☑
	Cement production	☑	☑	(☑)	☑
	Steel production	☑	☑	(☑)	☑
SDG 10 REDUCED INEQUALITY	Relative poverty (share of population below 50% of median national income)	☑	(☑)	(☑)	☒
	Inequality (average income of bottom 40% relative to national average)	☑	(☑)	(☑)	☒
SDG 11 SUSTAINABLE CITIES & COMMUNITIES	Floor space per capita (Residential / Commercial)	(☑)	(☑)	☑	☑
	Air pollution (urban areas)	☑	☒	☒	☒

[1] SSP1 is one of five Shared Socioeconomic Pathways (SSPs) described in O'Neill et al. (2017). The SSPs are a set of assumptions in climate and sustainability modelling, including among others projections for population, demographics, and gender-specific education outcomes. SSP1 is the most optimistic of the five SSPs.

SDG 12 RESPONSIBLE CONSUMPTION & PRODUCTION	Share of recycled steel	☑	☑	☒	(☑)
	Food waste	☑	☑	☒	☒
SDG 13 CLIMATE ACTION	CO_2 emissions	☑	☑	☑	☑
	Kyoto gases emissions	☑	☑	☑	☑
	Global mean temperature increase	☑	☑	☒	☒
SDG 14 LIFE BELOW WATER	*Note: This SDG is not covered as an output indicator. However, taking ocean acidification as an example, it is addressed implicitly as it is largely determined through the CO_2 budget. The budget chosen for the SDP scenarios limits ocean acidification.*	(☑)	(☑)	☒	☒
SDG 15 LIFE ON LAND	Biodiversity Intactness Index (terrestrial)	☑	☑	☒	☒
	Fertilizer use (nitrogen)	☑	☑	☒	☒
SDG 16 PEACE, JUSTICE & STRONG INSTITUTIONS	*Note: Peace and institutional quality are key enabling factors / prerequisites for achieving the SDGs. To a certain extent, this SDG is covered qualitatively in the SDP scenario narratives.*	–	–	–	–
SDG 17 PARTNERSHIPS FOR THE GOALS	Policy cost (of climate policy)	☑	☑	☒	☒
	International climate finance transfers	☑	☒	☒	☒

FAQ:

Are the IAMs used in SHAPE validated in any way? Do they correctly reproduce recent historical trends? What is the baseline year of the models?

Yes, the IAMs extensively use historical data on economic development, energy, land use, emissions, etc. to ensure that historical developments are matched. As most of the models work in 5-year timesteps, 2020 is the last year for which historical data (e.g., on GDP and population) is used. Certain parts of the models are even calibrated to reproduce historical observations, for example concerning historical energy use. Near-term trends projected by the models are also routinely compared to numbers published by e.g., international agencies.

Many IAMs follow cost-effective approaches, how does this affect the interpretation of the results?

The SDP scenarios follow a cost-effective projection combined with social, environmental, and technical drivers, and limits as specified by the SDP scenario storylines. Examples are more sustainable lifestyles, or upper limits on the use of carbon capture and storage (CCS). Thus, the results also imply transitions that are not driven by cost-effectiveness, but by a much broader set of environmental and social objectives. The different SDP scenarios also vary in this regard: The SDP scenario "Economic Innovation" relies more strongly on cost-effective approaches (as described in the storyline), in contrast to the SDP scenario "Resilient Communities" where sustainable lifestyles play an important role.

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More information about SHAPE's *Sustainable Development Pathways*:
https://shape-project.org/

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