1st Scenario Workshop: Phase 1 and Ahead

CROSS and CoSi Deep Dives

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This presentation was designed by the SWEET CoSi consortium, which is sponsored by the Swiss Federal Office of Energy's SWEET programme

Agenda

1. CoSi and Scenarios
2. Basic Scenario Framework
3. CROSS 2025 Scenarios
4. CoSi Deep Dives 2025

Where is CoSi coming from

CoSi formed as consortia for the 'SWEET: ***Co-Evolution Call 1-2022***'

Topic "Co-Evolution of the Swiss Energy System and Swiss Society and Its Representation in Coordinated Simulations"

Focusing on:

- ***Interaction between the energy system and society***
- ***Coordinate simulations***
- Integrate ***findings from social sciences and humanities***
- Provide ***focus reports*** every two years on stakeholder relevant topics

1st Objective: Modeling and Scenarios

CoSi aims to enhance energy scenario assessments by:

- Providing a ***coordination and exchange framework*** for researchers (continuation of SWEET CROSS)
- Developing and implementing a ***transdisciplinary exchange*** structure ensuring the integration of stakeholder perspectives
- Extending the modeling focus beyond energy system dimensions

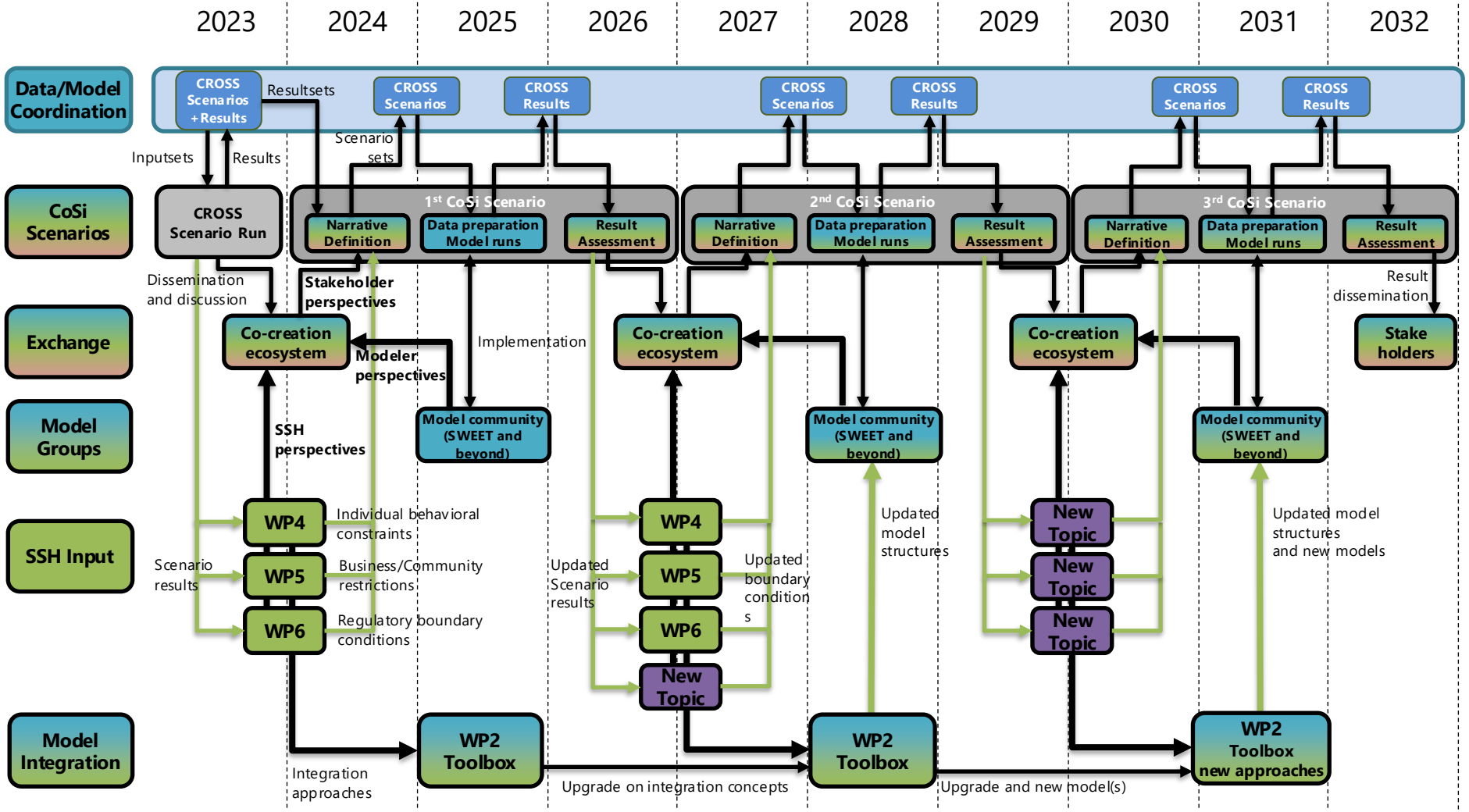
2nd Objective: SSH Integration

CoSi aims to enhance the integration across disciplines:

- Modeling still has a strong technical focus
- SSH research is often seen as add-on (i.e. acceptance of technical solutions)
- CoSi ***develops tools and methods to link*** technical and non-technical energy research
- ***Extends the scenario and modeling approaches*** to allow the integration of non-technical aspects and methods

CoSi aims to be a bridge between the different energy research communities from natural sciences and engineering, business and economics, and social science and humanities as well as between researchers and stakeholders

There was a large Roadmap



3 Scenario Assessments + final CROSS runs

CoSi roadmap

- Continuing the ***CROSS*** activities and finalize last scenario comparison (2023-24)
- Conduct ***three model scenario runs*** (24-26, 27-29, 30-32) gradually:
  - Including more SSH dimensions into the scenario structure
  - Extend the model capabilities
  - Ensure close linkage to stakeholder needs

CoSi was and is planned to support:

- Scenario design
- Data and result exchange
- Dissemination, engagement and discussion

What CoSi is and is not!

CoSi wants to be:

- A support structure for modelers and other energy researchers interested in future assessments of the Swiss energy system and its interplay with the society
- An exchange hub between researchers and between academia and stakeholders

CoSi was and is not planned to:

- Directly carry out most of the assessments (model based or otherwise)
- Finance model runs or assessments by research teams (without additional financial resources)
- 'Take over' results from other SWEETs or research teams or become 'the only' energy scenario activity in Switzerland

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Where do we stand today? Energy Scenarios in Switzerland

Energy Scenarios help us to better understand the future and make decisions today

One main Reference Scenario: ***Energieperspektiven***

Multiple other scenarios (i.e. VSE, energy companies, different research groups), plenty of modeling/scenarios within SWEET, and climate scenarios on top

Usually no ‘standardization’ or comparability of underlying assumptions

→Makes it hard to keep track of latest developments

→Makes it hard to compare findings between different models

What is the ‘Model Standard’? Techno-Economic Perspective

Most scenarios focus on an energy-system perspective; i.e. how to satisfy a given energy demand with a set of pre-defined technologies:

- Provide a theoretic benchmark (what can be achieved) but do not cover the question how to actually get it implemented in real world (i.e. what policies/decisions to make)
- No human decision making within the models
- No interaction/markets between actors/firms
- No political, regulatory of legal aspects as endogenous element

→Those model results need to be translated into ‘rea world’ wording

→The models can not capture a lot of real-world challenges

But those models do provide helpful insights!

CoSi 2024: Getting Feedback and Input

1. ***Modeling Workshop (March, 2024):***
   Presentation of CROSS results and discussion on model extensions, scenario design, and data exchange
2. ***SSH Energy Workshop (June, 2024):***
   Discussion with SSH researchers on ‘wishes’ from scenarios/modeling and general understanding on scenarios
3. ***CoSi Assembly and Site Visit (October, 2024):***
   Discussion with CoSi members, SFOE and Monitoring Panel on updated scenario structure
4. ***3x3 Board Stakeholders (April, 2025):***
   Final review of scenario structure

Modeler Feedback: What was Missing in Scenario Analysis so far?

Main replies (by order of mentioning):

1. Social acceptance (mostly constraints) and behavior
2. Flexibility
3. Carbon-Capture and Storage
4. EU & global interaction
5. New technology development & 'Nature'

Relatively sparsely mentioned:

1. *Policies & wider economy impacts*
2. *Spatial/Urban differences*

SSH Feedback
Key Take-Aways

Heterogeneous level of expertise and understanding of key concepts

- CoSi needs to develop a shared understanding of basic concepts and terms as well as a more specific framing of the opportunities for collaboration
- Focus in first phase more on capacity and community building and less on outreach and impact activities
- Additional provision of knowledge elements beyond meetings and workshops (modeling 1-0-1)?

Key contribution not provision of (better) data, but to challenge models and scenarios:

- Identifying blind spots of models, limitations beyond the technical layers
- Ex-ante and ex-post evaluation and reflection
- Translation into real world structures

Clear scenario audience needed:

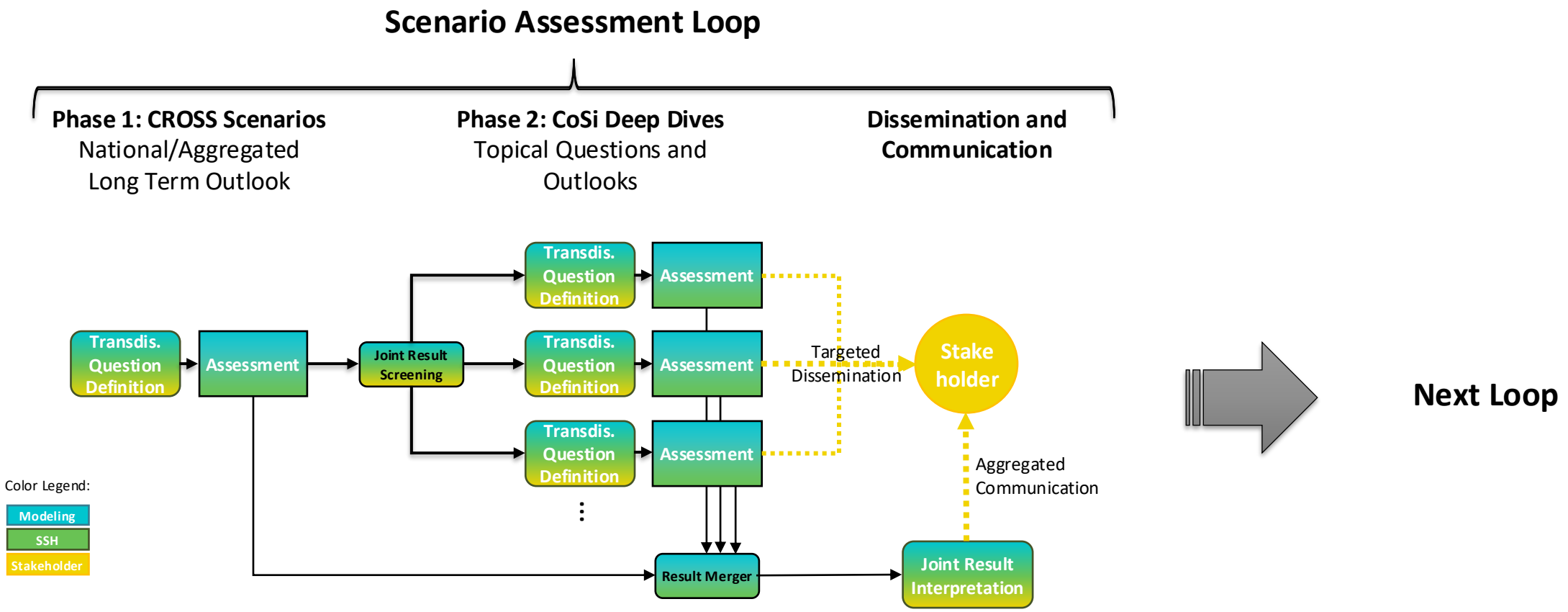
- Without a clear audience/purpose/use case in mind it is hard to effectively use SSH perspectives to improve the scenario development process
- Depending on purpose and use case SSH may provide valuable tools, perspectives and insights
- Key actors' decision making (within models) can help for use cases

Objective of Updated Scenario Assessment Structure

Based on the feedback and input, CoSi aimed to adjust its own scenario roadmap to address the following main points:

- **Continuity and Flexibility**: Integrating todays activities and be open for new elements
- **More 'Humans':** Both in modeling (i.e. behavior and decision making) and in useful data (i.e. actor and local data break-down)
- **Clear Use-Case/Purpose:** Clear definition of what is the question to be answered (i.e. think from the back), also enhances communication
- **Linkages to non-quantitative research: T**hose can challenge models and assumptions, reflect results; i.e. contribute ex-ante and ex-post to the model steps
- **Model capabilities:** Different models for different questions
- **Providing a 'fuller' picture:** Extend the range of covered variations (more model runs/sensitivities) development over time, embedding in larger socio-economic and political context

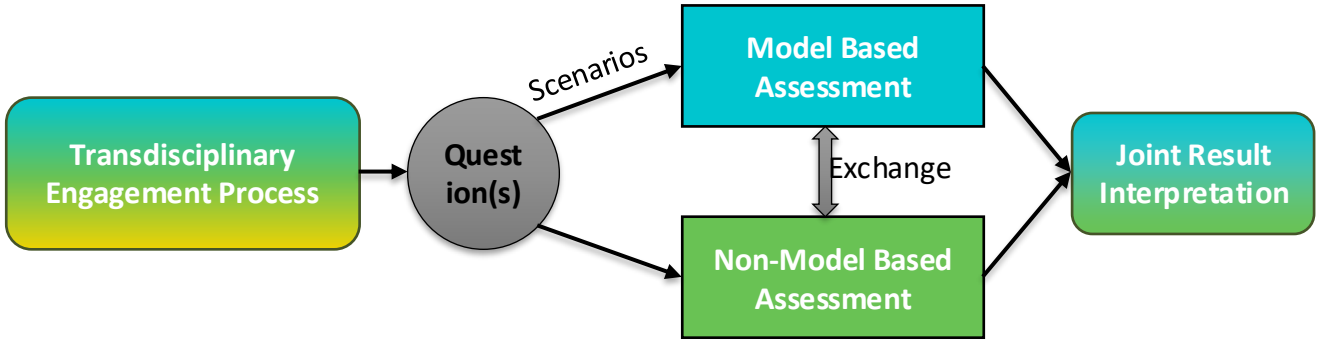
Framework Design



Basic idea:

Keep the energy system modeling as starting point and extend beyond

Main Element: Questions!



Main concept for deriving ***useful scenarios*** is to provide ***guiding questions***:

- Ideally the question is derived in a joint and transdisciplinary process to ensure that the purpose of the assessments is clear from the start (i.e. 'usability')
- The resulting research question can then be 'answered' by different means:
  - Classical or advanced numerical energy models needing 'scenarios' (i.e. datasets)
  - Non-model-based assessments focusing on the 'question'

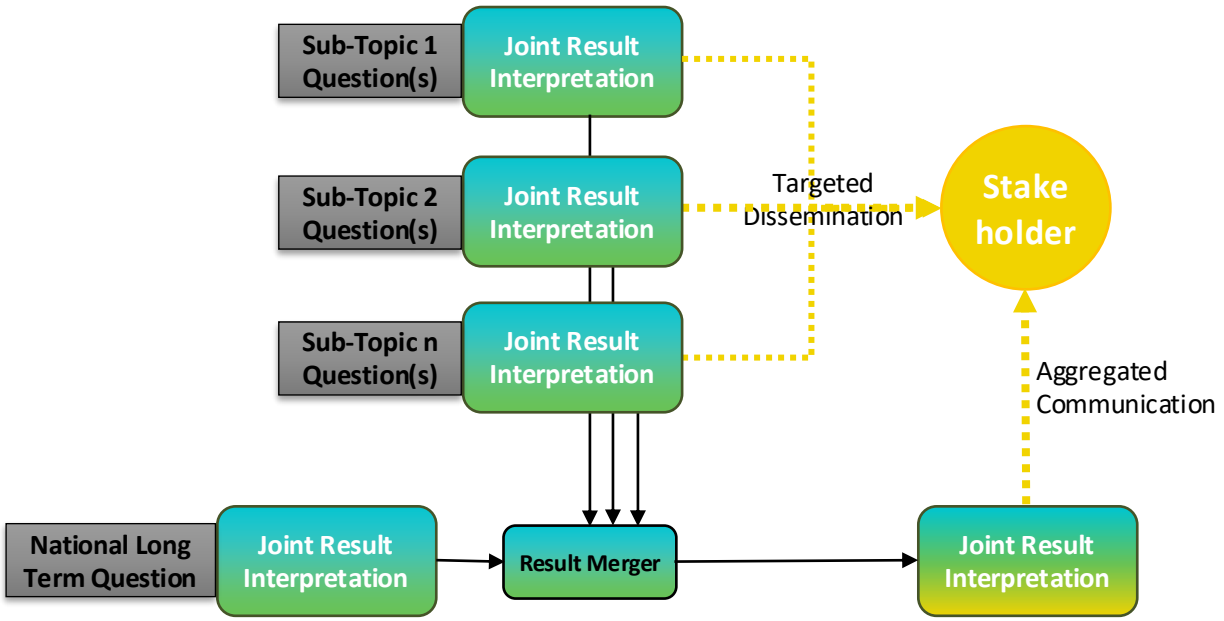
Envisioned Advantages

- Formalized structure of the workflow currently applied across community
- Aims to establish a ‘label’ that embeds all related activities and harmonizes the underlying data/scenario structure
- Opens up the model focused structure to non-model and qualitative research
- Different layers allow different groups to participate where their expertise is best utilized
- Easy adjustment over time to include new aspects/topics
- Focus on guiding questions provides a clear ‘use case’ of the assessments, is transparent for all participants, and provides openness for different methods beyond modeling

Challenges

- Establishing the needed (administrative) structure for all elements
  → i.e. CoSi as support structure
- Convincing participation of research groups and stakeholders
  → i.e. CoSi has no money for you…
- Establishing a successful engagement structure to identify ‘useful’ questions central
- Ensuring that assessment actually can contribute (i.e. how to handle ‘quality’ control?)

Dissemination



- Main dissemination should be focused on providing answers to the initial questions for each phase/topic
- All results are to be gathered and put into an overarching representation (i.e. report/webpage) that is accessible for different stakeholder groups
- Each model group remains able to conduct individual result dissemination

Dissemination: Work in Progress

Dissemination still has to wait a bit: Current focus on getting scenarios up and running and Phase 1 and 2 established

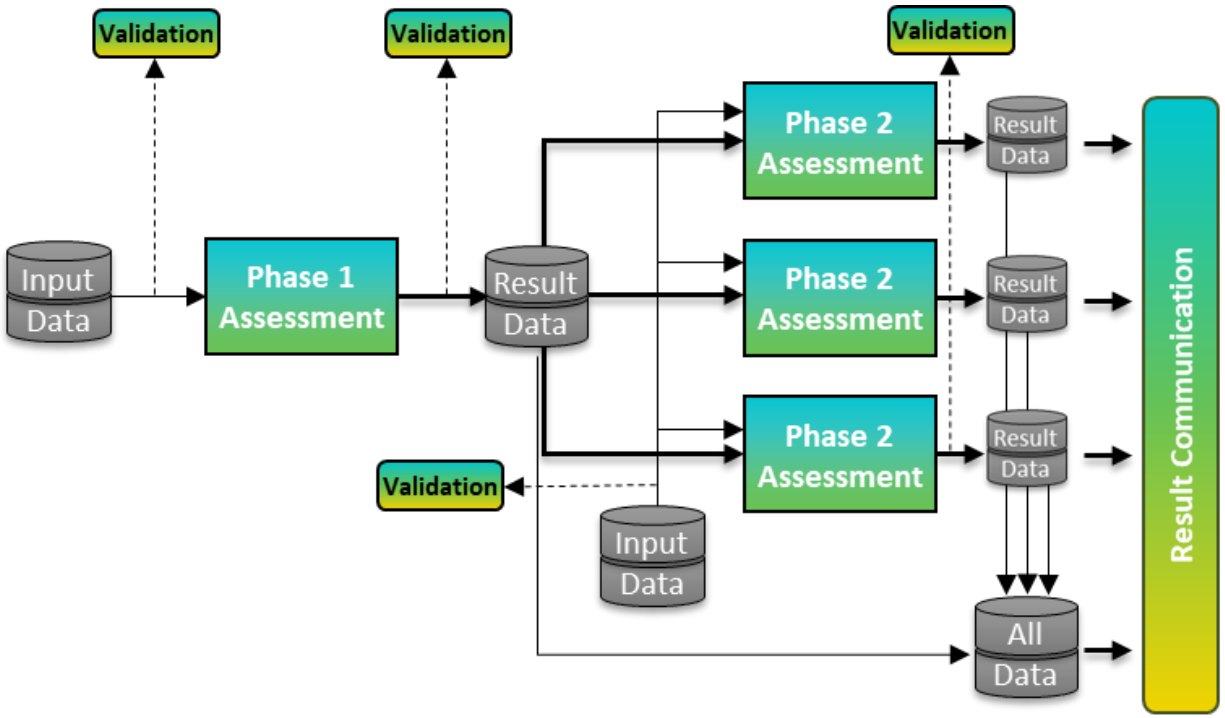
Envisioned Advantages of Dissemination structure:

- Linkage of all result communications with the larger overarching structure eases the embedding of the own findings (i.e. all results are part of the harmonized scenario/data structure)
- Focus on questions as driving element provides an anchor point for communication
- Sub-topics provide a clear stakeholder group to be targeted

Main Challenges:

- Joint interpretation may not lead to agreement on joint insights → communication strategy needed on how to disseminate (i.e. lead group or all participants responsible)
- Develop support structures for interdisciplinary result communication (e.g. communication guidelines?)

Data Exchange



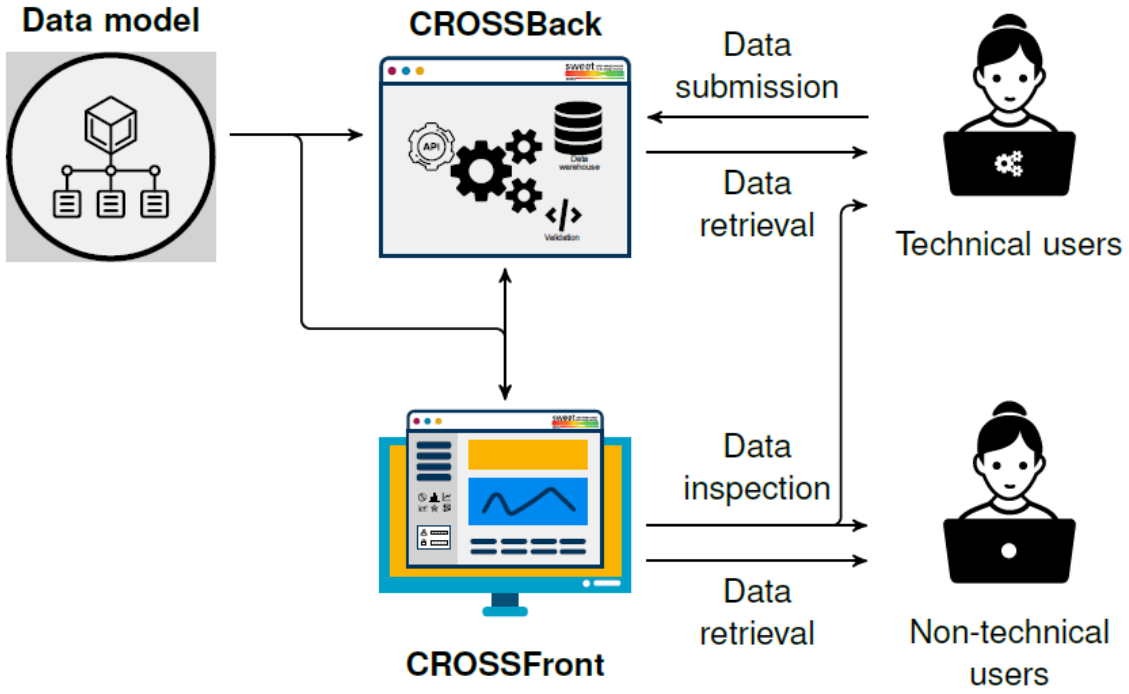
- Scenario structure will be supported by a data architecture that ensures a consistent flow of numerical data between the phases and participating teams
- The main internal data flow will go from the phase 1 assessment to the phase 2 assessments
- Each phase will be complemented by external data inputs for the respective models/assessments
- All result data will be merged and provided for the communication activities
- Both input and output data needs to pass a validation step (ideally not only an automated one, but also a ‘manual’ sanity check by experts)

Data Exchange: CROSSFit

Objective: Facilitate seamless data exchange between models of different teams while ensuring that results are accessible to CoSi stakeholders

CROSSFit aims to:

- Provide structured storage of scenario assumptions, efficient data exchange, systematic scenario result uploads
- Enhance the usability and accessibility of analyses via tailored visualization tools that present scenario outcomes in a clear and intuitive manner, catering to the specific needs of different stakeholders
- Foster interoperability, transparency, and collaboration

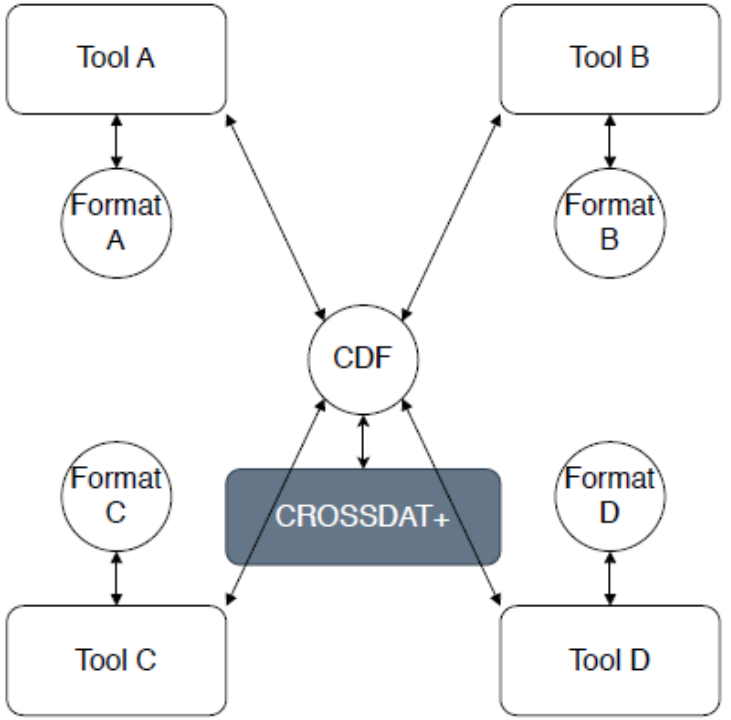


Data Exchange: Common Data Format (CDF)

Objective: Standardize the format for exchange between modelers both in a centralized structure (i.e. CROSSFit) and bilateral, enable visual data assessment

CDF aims to:

- Provide a clear variable mapping for standardized exchange and linking to individual models
- Data format and template for exchange
- Test and improve the data format via the CoSi scenario assessment to provide a long-term template for the future



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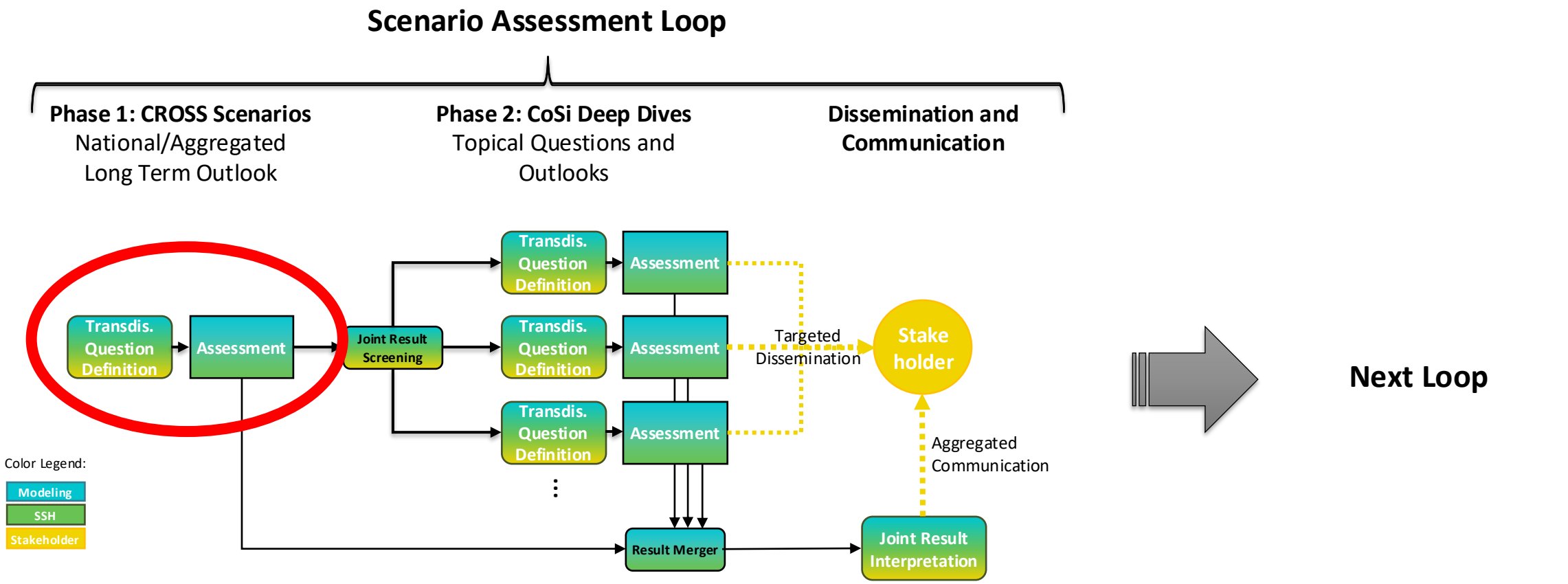
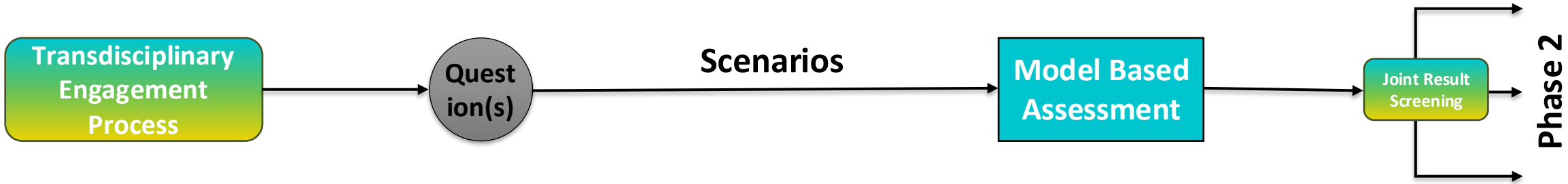
CROSS 2025: What are we talking about?



CROSS 2025: Timeline



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Gathering input from Stakeholders via CoSi WP3 and 3x3 Board

Today!

Finalization of Guiding Questions

Until June 25

Translation of questions into numerical scenarios via CoSi WP1 and model teams

Summer/Fall 25

Model teams run the scenarios

Fall 25 onwards

Transition from Phase 1 to Phase 2

Starting Point For CROSS 2025

CROSS 2022 scenario comparison provided quantification along the lines of EU-CH integration and carbon abatement abroad/domestic

Building upon CROSS structure:

- Define the guiding research question(s) for the first phase
- Focus on ***national energy system*** perspective
- Focus on questions that can be addressed with ***exciting models***

CROSS 2025 is not aiming at directly including SSH or policy structures into the models (→ Phase 2)

Preparing the Stakeholder Input

Review of existing stakeholder inputs form other SWEETs and own previous exchange:

- Meeting between CROSS and Federal Offices: Net-zero target, renewable energy targets, aviation emissions, EU legislation alignment.
- SWEET-PATHFNDR Stakeholder Workshop: Collaboration potential, EV-related issues, flexibility potentials, bidirectional charging concepts.
- Feedback from SWISSOLAR: Grid management, PV production peaks, market prices, extreme scenarios.

→ Providing starting points for potential questions and ideas for specific topics (Phase 2)

Direct Stakeholder Input: Federal Offices as 'Focus Group'

Development of own small ***question set*** to gather CoSi-specific and up-to-date insights. Focus on what stakeholders are:

1) interested in (→ question) and
2) how they use models/scenarios in their daily work (→ usability)

Limited number of stakeholders for questionnaire

→Focus on sub-set of stakeholders that are likely interested in energy developments on a national layer, but have a diverse perspective

→Federal Offices as 'focus group':

- Interview study with energy modelers conducted in autumn 2024 identified the federal administration as a key stakeholder group
- Federal offices span a broad range of expertise able to provide integrative, cross-sectoral insight
- Operate at the national level
- Clearly defined sample frame

Feedback

Beside many detailed and specific needs, a set of more ***common interests*** emerged:

- **Flexibility and System Integration**: Stakeholders are interested in the potential of flexibility options including the legal, economic, and infrastructural factors crucial for their implementation.
- **Security of Supply and Seasonal Challenges**: Given concerns about winter supply-demand imbalances and resilience during extreme events, scenarios should also test stress conditions.
- **Aviation**: Aviation emissions are an important part to achieve the climate targets but have a high dependency on international developments and uncertainties.
- **Electrification**: Stakeholders question how the speed of the electrification impacts the rest of the system developments and needs.
- **Dependency**: Key technological options depend on existing enabling infrastructure, creating potential path dependencies. Scenarios should reflect infrastructure availability as a variable.

Feedback

Beside many detailed and specific needs a set of more ***common interests*** emerged:

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- **Security of Supply and Seasonal Challenges**: Given concerns about winter supply-demand imbalances and reliance during extreme events, scenarios should also test stress conditions.
- **Aviation**: Aviation emissions are an important part to achieve the climate targets but have a high dependency on future technology developments and uncertainties.

Already planned as topic for Phase 2

Coordination with SWEET RECIPE

Mostly data adjustments possible

- **Electrification**: Stakeholders question how the speed of the electrification impacts the rest of the system developments and needs.
- **Dependency**: Key technological options depend on existing enabling infrastructure, creating potential path dependencies. Scenarios should reflect infrastructure availability as a variable.

Feedback 2

Insights with respect to ***user perspectives*** and ***engagement*** needs:

- Scenarios must align with the existing policy frameworks and official planning documents.
- Stakeholders have differing and sometimes even contrasting expectations for scenarios (e.g. scenarios that explore a wide space of possible future developments vs. focusing only on most probable scenarios), reflecting their varied roles.
- Administrative stakeholders have limited capacity to engage actively but are interested in tailored outputs.

→ Highlights the ***need for scenarios to be practical, aligned with policy, and considerate of stakeholder engagement and expectations.***

No 1: A Wish/Requirement

How does the Swiss energy system develop under currently given policies and targets?

- Reference scenario that aligns with existing policy frameworks and official planning
- Allows comparison to other important Swiss energy scenarios (i.e. Energieperspektiven)
- Basis for other scenarios and sensitivities (e.g. withdrawing intermediate targets, extending policies etc.)

No 2: Speed

What is the impact of a faster or slower development of important system trends, in particular the electrification of mobility and heating or other trends?

- Most stakeholder see electrification of key sectors (transport and heating) as central for the transition. It likely has significant implications for infrastructure needs, energy demand, and system financing → can likely alter costs and needed speed of RES extension

- Possible ‘trend' options:
  - Faster/slower EV take-off
  - Faster/slower electric heating take-off
  - Demand increases from data centers/digitalization
  - Other ideas?

No 2: Suggested Guiding Question

Does a faster electrification help the transition towards renewables?

No 3: Key Bottlenecks

What are the consequences of delayed availability of critical key infrastructures?

- The path of the transition may be altered by the availability of specific technologies (outside of the Swiss scope) or the acceptance of specific solutions
- Some could be key elements that reshape the energy transition significantly (path dependencies?)
- Possible options:
  - (Non)Availability of carbon removal (mentioned by several stakeholders)
  - (Non)Availability of hydrogen or other synthetic fuel imports (i.e. important for aviation)
  - Network access (i.e. to gas, hydrogen, synthetic fuels) as important constraint
  - Debates about new nuclear, specific new storage technologies, mountain solar

No 3: Suggested Guiding Question

How important is the access to a European hydrogen system?

What is next?

Next Step: **Scenario definition**

Using the final guiding question, CoSi will:

- Conduct an exchange with model teams to translate them into a basic scenario setting
- Develop numerical scenario datasets for implementation in energy system models
- Provide the data templates for interested model teams

→ CoSi WP1 in charge (the **CROSS team**)

How can I join?

If your research team:

- Thinks the questions are interesting
- Has an energy system model readily available
- Has resources to run a set of scenarios in summer/fall 2025
- Is willing to join the data exchange structure

→ Contact us!

If your research team:

- Is interested in some aspects or other potential questions
- Has modeling or other energy related methods available
- Has resources to conduct research in late 2025 or 2026
- Is willing to join the data exchange structure

→ Join Phase 2!

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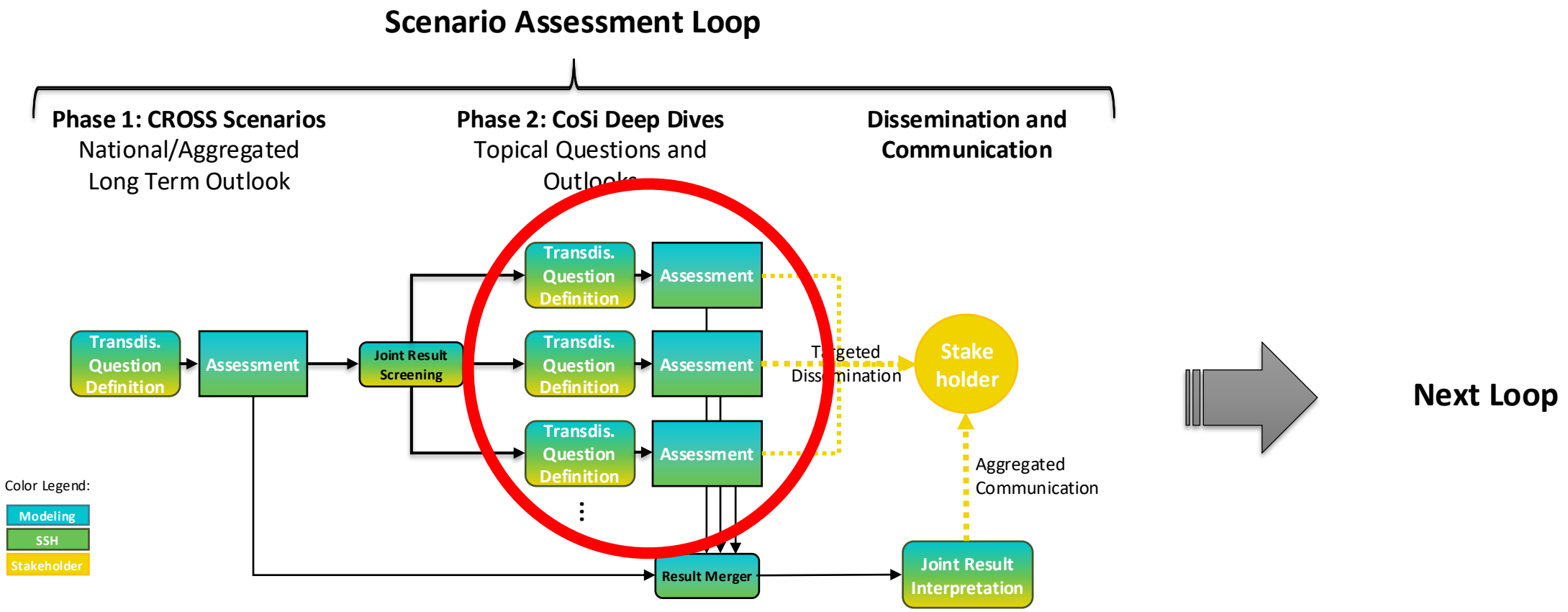
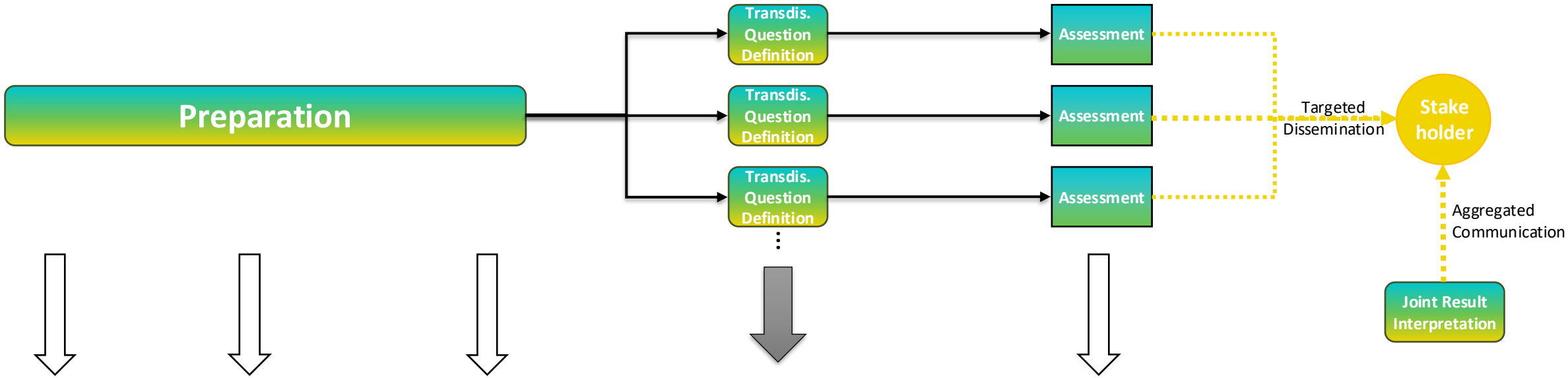
CoSi Deep Dives: What are we talking about?



CoSi Deep Dives 2025: Timeline



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Input from CROSS Stakeholder process

Today!

Identification of further topics and interested teams

Summer 2026

Preparation of topics with teams and stakeholders

Fall/Winter 2026

2nd Scenario Workshop

Joint definition of final guiding questions for Deep Dives

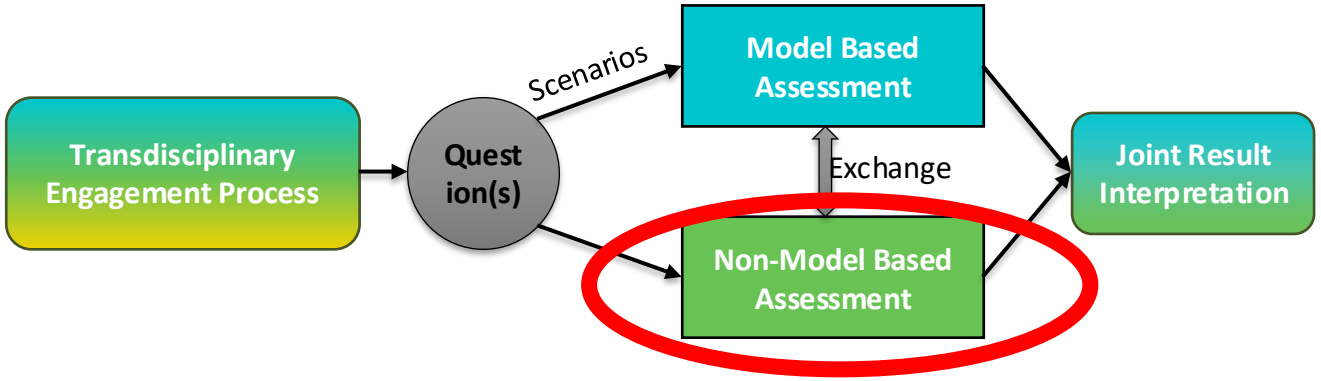
2026

Research teams perform their assessments

Fall/Winter 2026

Overall result review and dissemination

Remember:
Assessment don't need to be model based



The main idea for the Deep Dives is to investigate relevant questions using the data provided by CROSS 2025 as underlying numerical backing

→Methods are not limited to model approaches

→Scenario definition will follow similar logic as CROSS (i.e. done with the modelers after the question is fixed)

CoSi Topics by Definition?

→ Decision Making and ABMs as starting point

→ Business models and energy communities as focus

→ Critical reflection of scenario assumptions

(SSH) Ex-Post Evaluation as Deep Dive

CROSS 2025 results will be techno-economic

- Need to translate into ‘what do we need to do now’ insights
- Limited representation of political, economic and social structures in the models calls for critical review

→ Numerical scenario assessments should be complemented by ex-ante and ex-post evaluation

→ Deep Dives are by design ex-post, but are also ex-ante for the next loop

→ Non-model based assessment can be coupled with modeling (i.e. rerun the CROSS 2025 scenarios with adjusted scenarios)

Data Crunching as Deep Dive

CROSS 2025 provides plenty of details

- Enable deeper investigation without need for model reruns
- Can be coupled with other assumptions to provide ex-post numerical insights

→ Detailed stakeholder questions (i.e. stock of specific cars over time) sometimes are simple data needs

→ Especially financial insights can be directly derived from CROSS 2025 results (i.e. altered tax flow depending on different car/mobility taxes), albeit without altering incentives in the model (→ options for follow-up model runs)

CROSS 2022 insights

Hydrogen:

- High level of uncertainties
- Availability has high potential for large system implications (→ CROSS 2025)
- reFuel.ch joined the SWEET family with a strong focus on this topic

Flexibility:

- Availability of assets (investment) as well as operation (incentives)
- Also large stakeholder interest (Federal Offices and others)
- Strong electricity focus

Grids

Transition of the natural gas grid:

- Linked to hydrogen topic
- Time structure of access/no access can be crucial for specific technology options and thereby pathways

District heating vs. heat pumps:

- Development in urban areas → local model needed?
- Relation between extension of district heat systems and connection of new customers vs. their incentive to build a individual heat pump solution (i.e. in combination with PV)

Grid costs as a central block for firms → getting a better understanding and estimations highly welcome

Regional Insights

High interest in regional and local insights **from research community and stakeholders alike**

Potentially also linked to **grid topics** (gas but also distribution grid aspects)

Any Economists?

Currently rather small **capability for economic follow-up assessments** (CGE based) in Switzerland but generally high interest (e.g. also part of the Energieperspetiven call)

Business strategies (Key actors, their strategies, what they can implement, what impedes them to take up their strategies)