

PRESLHY

Prenormative REsarch for Safe use of Liquid Hydrogen



ISO TC 197 PWI 24077 → WG29 Sub-task 2

Thomas Jordan, KIT; Dissemination Conference; 5-6 May 2021

Pre-normative REsarch for Safe use of Liquid HYdrogen

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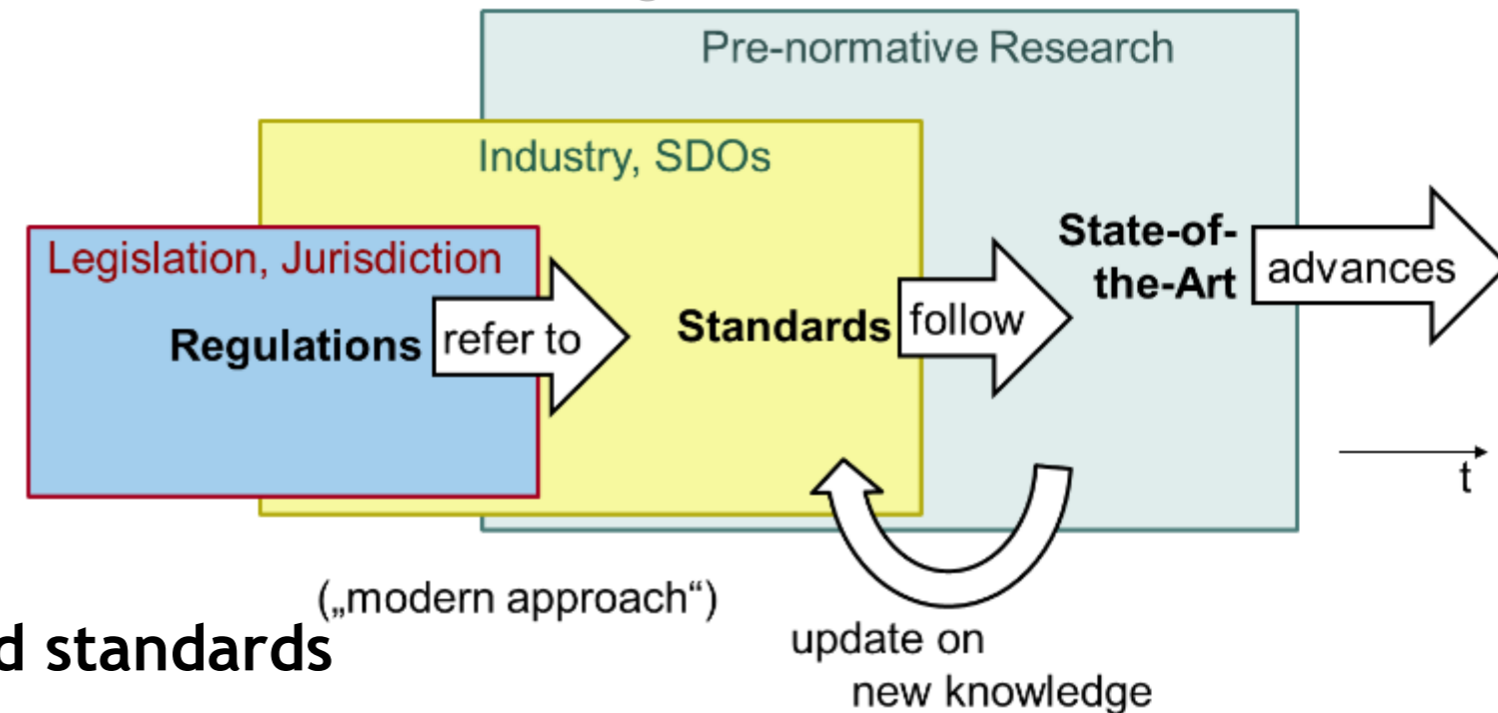
PRESLHY Objectives

- Report initial state-of-the-art and knowledge gaps with priorities wrt intended use of LH2
- Execute adjusted experimental program addressing release, ignition and combustion phenomena with highest priorities
- Document and publish detailed, aggregated and interpreted data in a FAIR way
- Develop suitable models and engineering correlations and integrate them in a suitable open risk assessment toolkit
- Provide enhanced recommendations for safe design and operations of LH2 technologies
- Support international SDOs in
 - updating of existing standards or
 - developing of new international performance based and risk informed standards
- Document and disseminate the enhanced state-of-the-art

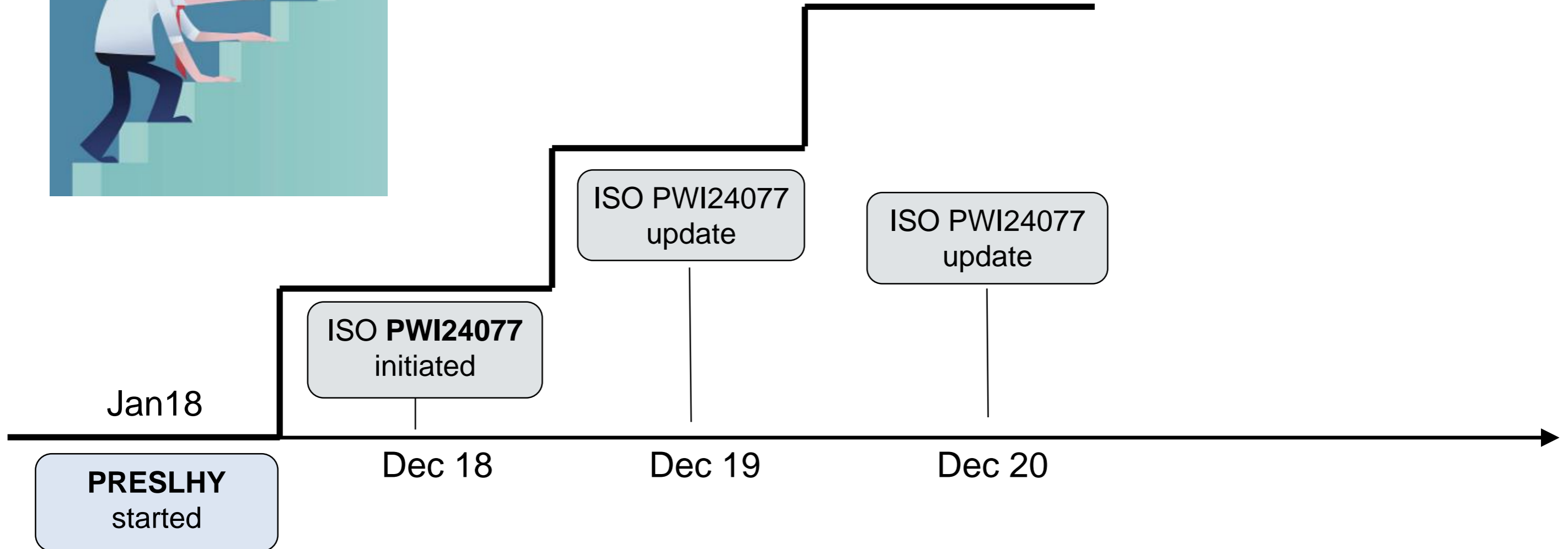


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Stairways to standardisation



Where we are today wrt highly ranked LH₂ safety topics?



Ad Priority 1: Multi-phase accumulations with explosion potential

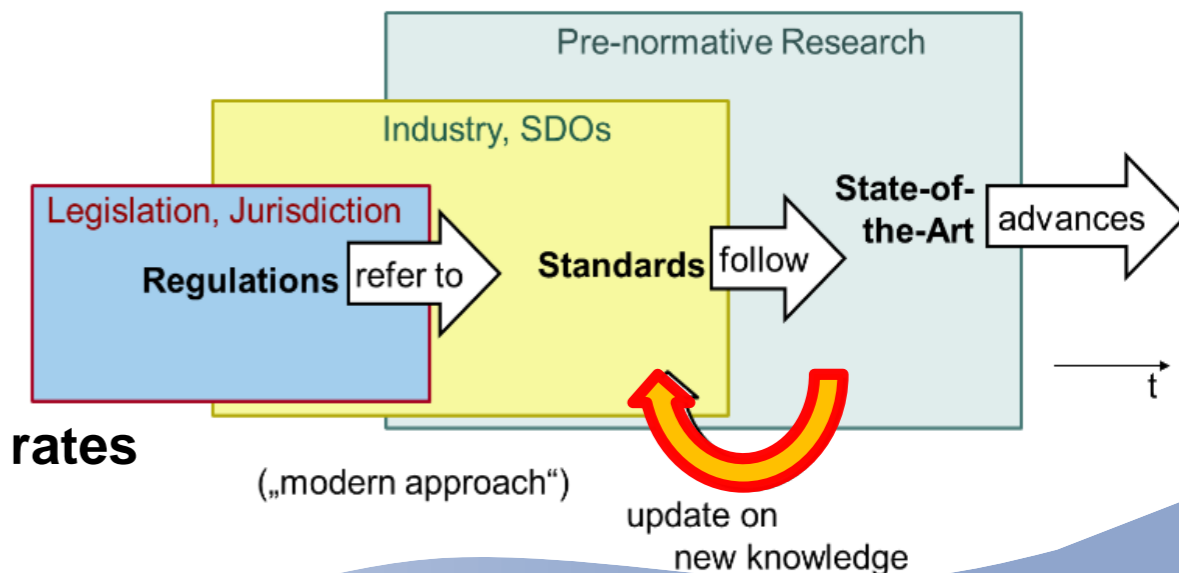
- ✓ Repeated spill in gravel bed might generate dangerous condensed phase mixtures; not for other substrates
- ✓ Water sprays on LH₂ and LH₂ spill on small water pool seem to be non critical

Ad Priority 2: Combustion properties of cold gas clouds, especially in congested area

- ✓ Higher expansion ratios come with higher critical expansion ratios
- ✓ Uncongested mixtures behave less critical
- ✓ Density effects might promote strong pressure effects in particular for congested areas

Ad Priority 3: Knowledge and experience related releases involving large quantities

- ✓ Large discharges do not generate static electricity or promote spontaneous ignition under normal weather conditions
- ✓ Spills shall be trenched and kept in a pool with low release rates



Proposed pathways

- ❖ **Revision of specific standards**
ISO 13984:1999 (vers 4) and ISO 13985:2006 (vers 3)
- ❖ **Revision and/or extension of „generic“ technical report on hydrogen safety**
ISO TR 15916:2015 (currently under review; chaired by J. Keller)
- ❖ **Separate stand-alone document**
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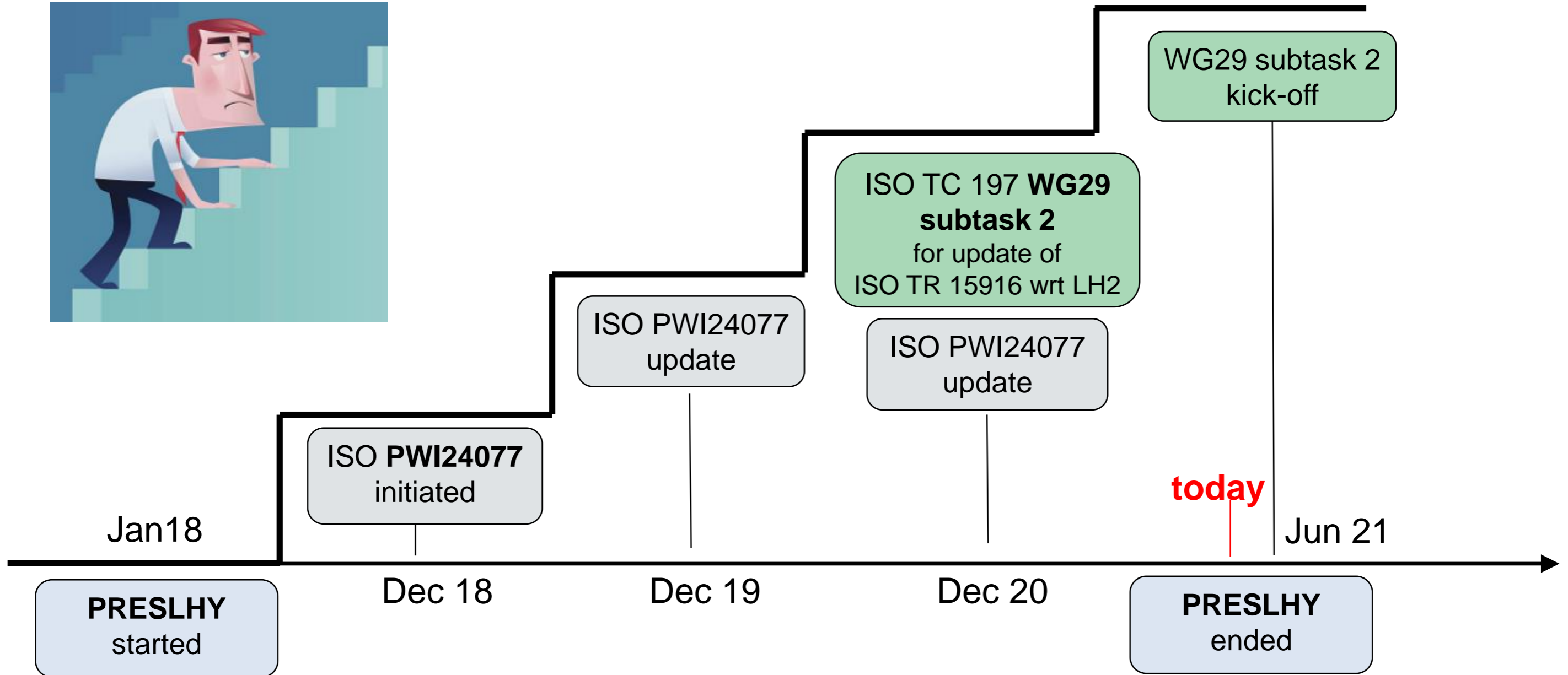
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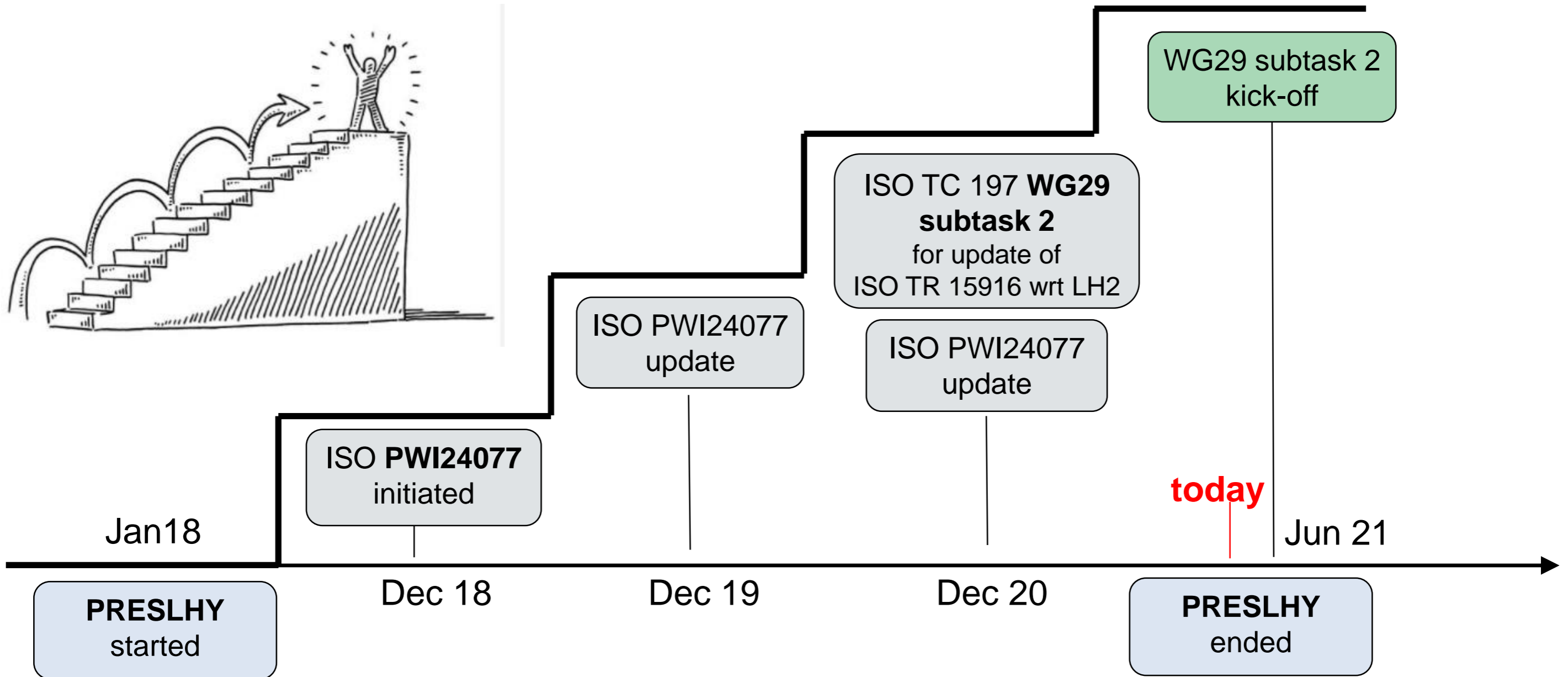
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ISO TC 197 WG29 subtask

- Indicate your interest to national mirror committee
- Join the **kick-off meeting** (date in June 2021 to be published via ISO TC 197)
- Inject your view in the revision of ISO TR 15916:2015
- Meeting in September 2021 (in combination with )
- Meeting in December 2021 (in combination with ISO TC 197 plenary)
- Closing meeting in April 2022

- Direct contact: Thomas Jordan (Thomas.Jordan@kit.edu);
WG29 convenor Jay Keller (Jay.Keller@zces-inc.com)



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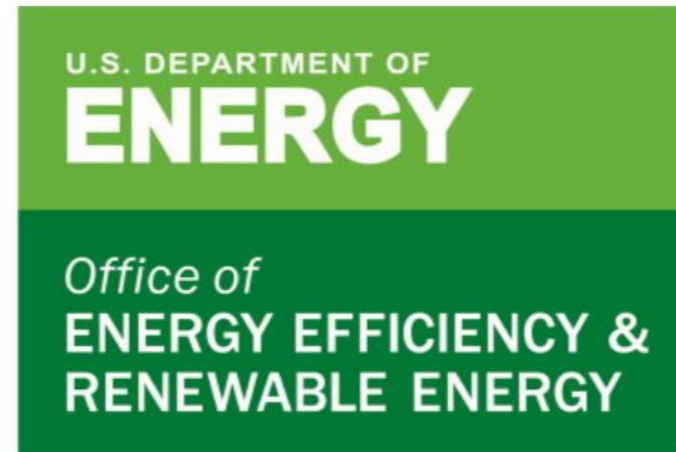
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Future work, open issues, priorities



Fundamental/Modelling:

- ? Clarify material issues with cryogenic hydrogen
- ? improve thermodynamic modelling in multiphase, non-equilibrium, reaction kinetics (< 200K)
- ? determine induction times and detonation cell sizes (< 200K)

Dispersion phenomena:

- ? Ventilation of closed rooms and interaction with other mitigation concepts
- ? Multiphase effects on large scale dispersion with obstruction and/or (partial) confinement

Combustion phenomena:

- ? Broader assessment of FA and DDT for varying congestion and confinement at larger scale
- ? Evaluation of detonation potential of solid O₂ in LH₂ pools
- ? Scaling of BLEVEs

Risk assessment and mitigation strategies:

- ? Proper design and approval of safety valves
- ? Integral (applied) tests (dispersion and combustion in closed rooms) for mitigation strategies, including sensor placement and performance
- ? Crash test for vehicle tank systems