U.S. DEPARTMENT OF ENERGY

Next Generation Waste Glass Melters

The U.S. DOE Waste Processing Program

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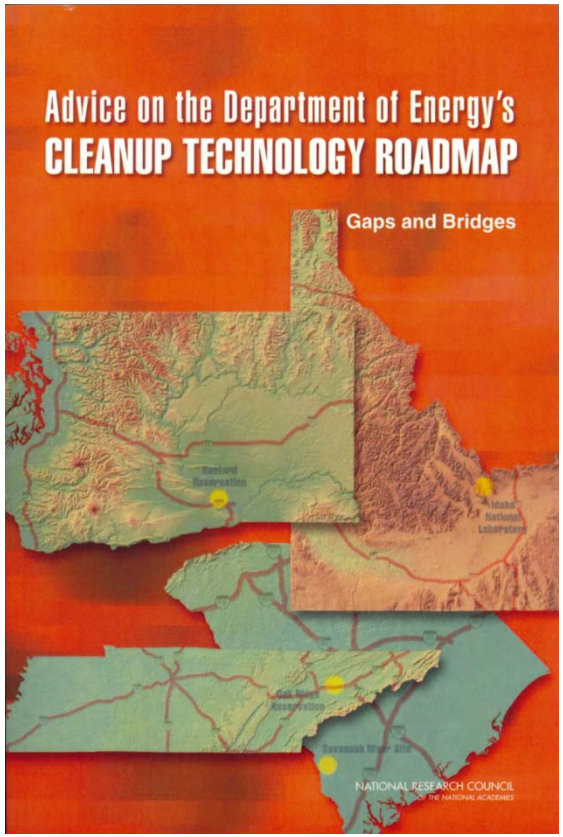
U.S. National Academy of Sciences Roadmap Recommendations



- **Recognizing the importance of melter technology to the DOE cleanup mission, NAS recommended research into advanced melter technologies.**

  "*Increased vitrification capacity may be needed to meet schedule requirements of EM's high-level waste programs*."

- **Specifically they recommended development of:**

  –*Alternative melter designs, with special attention to induction melters or other types of melters that have high throughput relative to their size.*

  –*New methods of enhancing mixing in Joule-heated melters to increase their capacity. Bubblers can improve mixing, but they have potential technical problems associated with corrosion/erosion of the bubbler tubes and other components, and disturbing the cold cap.*

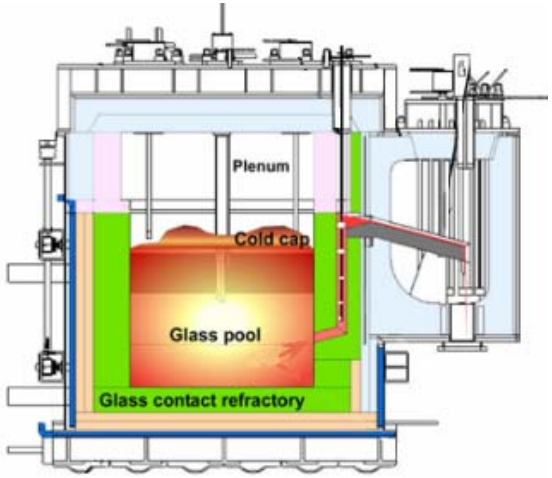
  –*Alternatives for boosting heat input to Joule-heated melters. Microwave heating might be one.*

DOE-EM Office of Waste Processing Response

DOE-EM has initiated "Improved Vitrification Capacity" activities as described in EM Tank Waste R&D Plan. Melter project in support of this activity.

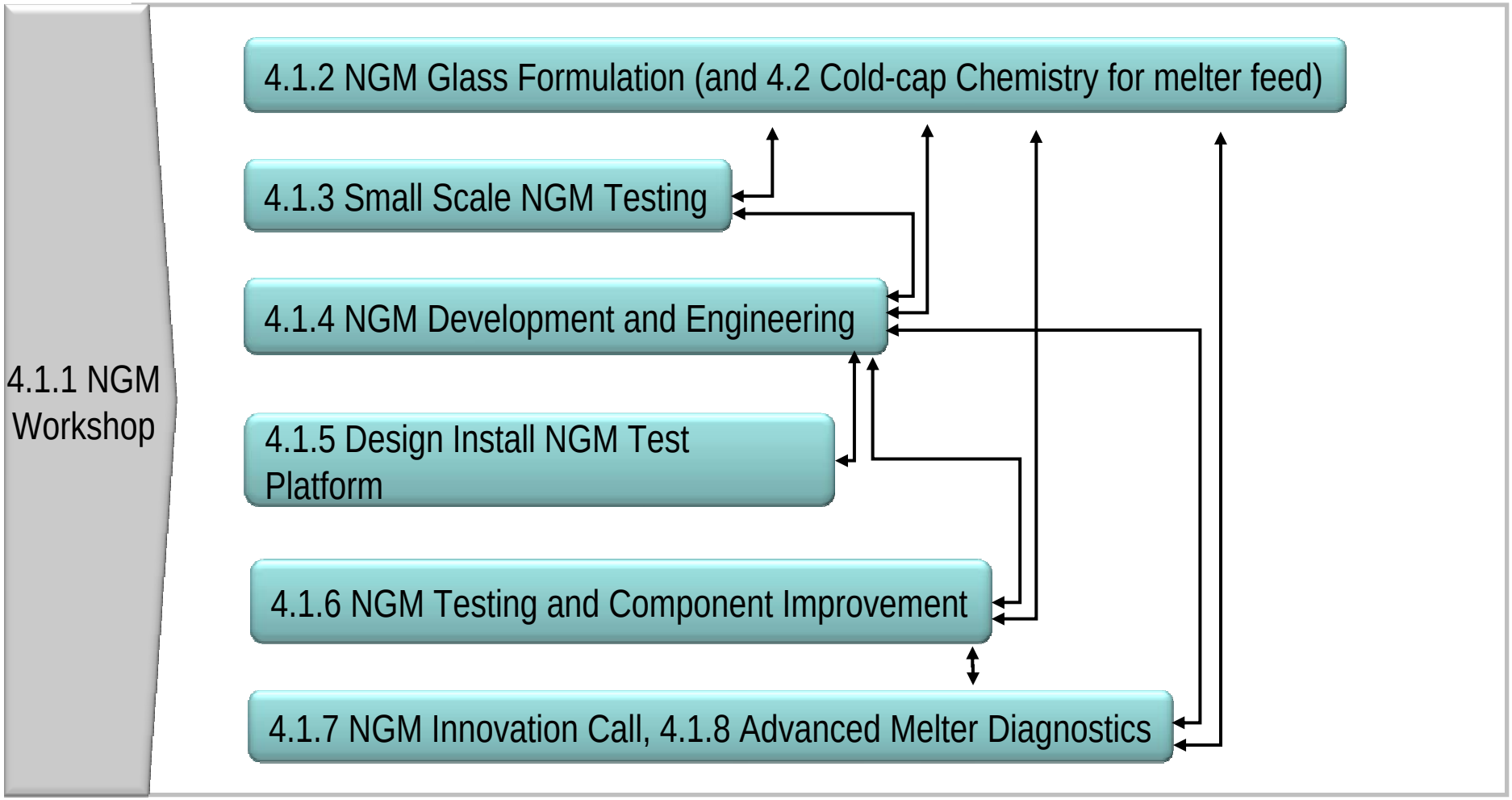
Facets of WTP processing being investigated/enhanced include:

- **Waste Loading in Glass**
- **Melter Processing**
- **Melter Design & WTP Compatibility**

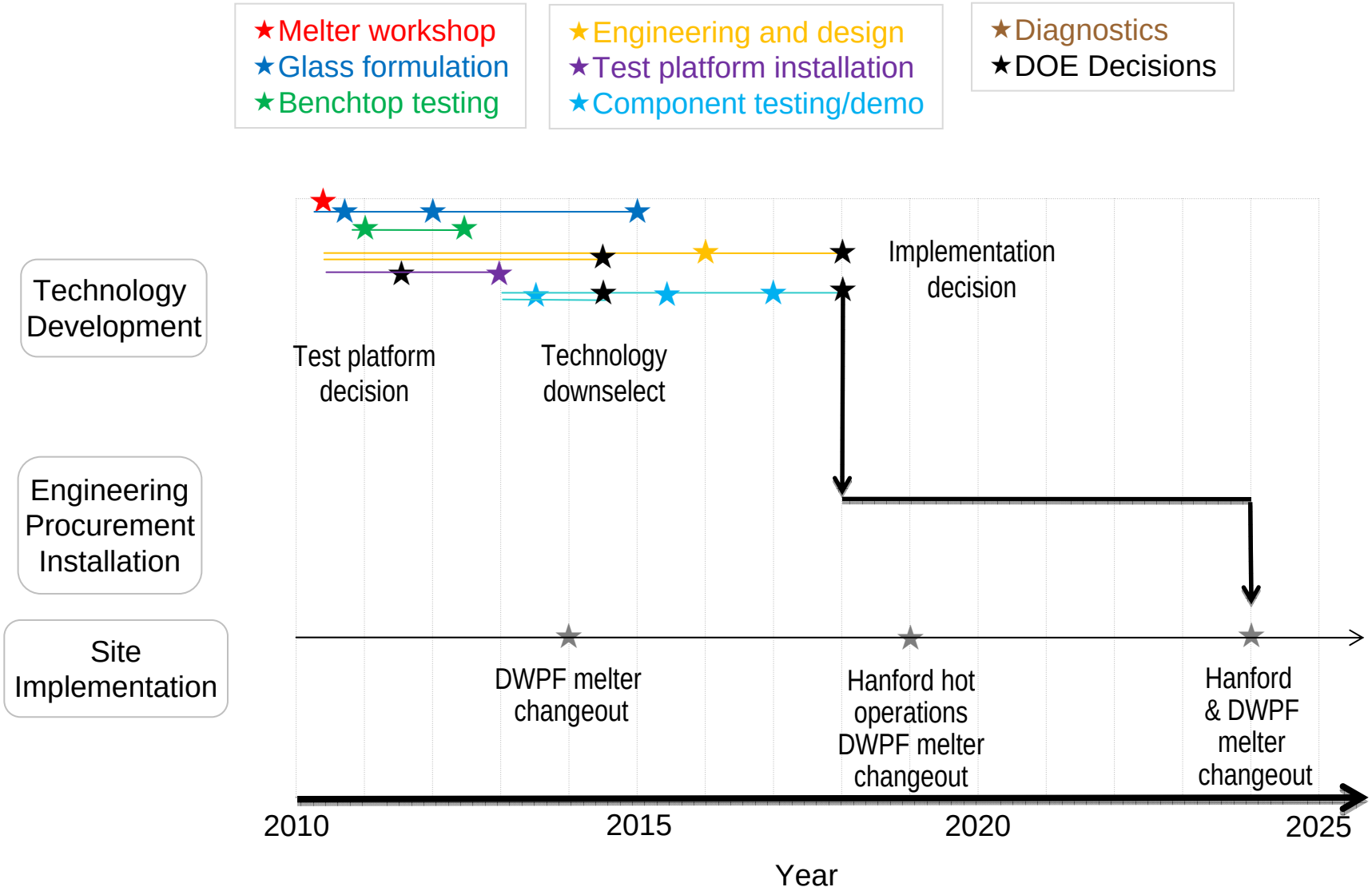


Next Generation Melter

Initiative Organization



Timeline: Next Generation Melters

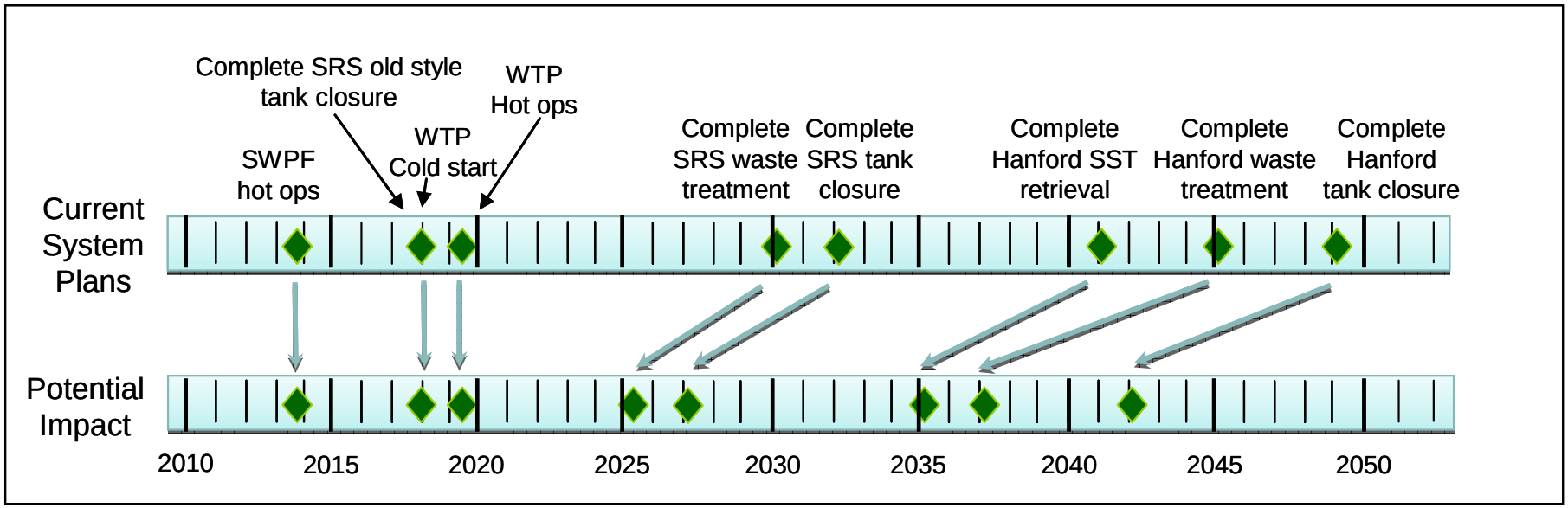


Costs/Schedule Incentives

- Improved waste loading in glass can reduce the amount of glass to be disposed of → resulting in significant cost savings
- Increasing waste throughput can reduce waste processing schedule, saving facility operating costs

Waste Throughput = Waste Loading × Melting Rate

- Advanced melters can also reduce pretreatment requirements



Performance Targets

NGM Melter Designs — Joule Heated Ceramic Melter (JHCM); Cold Crucible Induction Melter (CCIM)

NGM JHCM Features	HLW	LAW
Increased Surface Area (SA)	25%	50%
Improved Bubbler Package	8 vs. 5	25 vs. 18
Increased Temperature	~50°C	~50°C

NGM CCIM Features	HLW	LAW
Increased Temperatures	≥150°C	50-100°C*
Greater Throughput per SA	2X	2X

NGM Goals (MT glass / day / melter)	HLW	LAW
Current WTP	3	15
Project	4	21
Max Target	6^{+}	35^{+}

** Sodium content (glass flux) may obviate large temperature gains.*

NGM Technology Exchange

- **international technical exchange from March 3-5, 2010, Washington, DC**
- **assessed "state of the art" in nuclear waste glass melter technologies**
- **used to help U.S. develop the next generation of waste glass melters**
  - improve vitrification performance
  - enhance waste feed throughput
  - increase waste loading into the glass

NGM Glass Development

- **Develop glass formulations for the next generation nuclear waste melters**
  - demonstrate glasses with increased radioactive tank waste loading
  - demonstrate waste melter feeds and glasses with higher throughput rates
- **Wastes identified that contain many troublesome waste glass-forming components**
- **Glass compositions developed to maximize loading of representative wastes containing these problematic components**
  - demonstrate the ability to process these compositions and realize waste throughput gains
  - borosilicate glass formulations for AJHM
  - borosilicate glass formulations for CCIM
  - iron phosphate glass formulations

NGM Small Scale Melter Testing

- **Perform bench-scale melter testing to generate data necessary for preliminary design of the melters**
  - advanced Joule-heated ceramic melter (AJHCM)
  - cold crucible induction melter (CCIM)
- **Evaluate the suitability of the melter for particular radioactive tank waste types and glass formulations**
  - particularly advanced glass formulations such as iron phosphate glasses
  - materials of construction corrosion
  - compatibility of off-gas treatment components
  - sizing calculations

Next Generation Melter Development and Engineering:

- **Perform engineering studies to determine the requirements of induction-heated and advanced Joule-heated melter installation and operation in the Hanford Waste Treatment and Immobilization Plant (WTP)**
  - preconceptual design
  - integration of melters with required services (e.g. electric, water, air, melter feed, etc.) into existing facility

Programmatic Impact & Limitations

Programmatic Impacts

1) Potentially 2X increase in WTP HLW and LAW waste processing rate.
2) Process chemical control strategy upgrade required to accommodate increased waste loading and higher temperature compositions.
3) WTP impacts for review (minimum):
    1) Reduced analytic turnaround time
    2) Melter power supply size (JHCM and CCIM)
    3) Induction melter requirements (CCIM)
    4) Melter cooling water (CCIM and JHCM)
    5) Canister handling
    6) Off-gas system

2011 Plans

- **Continue glass formulation to take advantage of unique next generation melter capabilities**
  - CUA (lead for AJHCM), PNNL (lead for CCIM), SRNL (support both)
  - time sensitive
- **Receive recommendations for test systems from vendors**
  - AREVA, WRPS, ES, KHNP