

# Light Water Reactor Sustainability Program

## Report on the Use and Function of the Integrated Operations Capability Analysis Platform and the LWRS Innovation Portal



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U.S. Department of Energy

Office of Nuclear Energy

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# **Report on the Use and Function of the Work Function Analysis Tool and Nuclear Innovation Portal**

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## SUMMARY

The commercial nuclear power industry has achieved excellent safety and reliability performance but is struggling to survive in an electricity market that is increasingly dominated by subsidized renewables and cheap natural gas. These challenges have forced utilities to explore new avenues to drastically reduce the operations and maintenance costs of their plants, which are the primary drivers of the total cost to produce electricity.

The North Sea oil and gas industry faced similar challenges some years ago as the costs of extraction and processing were rising while their reservoirs were being depleted, along with a drop-in commodity prices that resulted in unsustainable operations. In this challenging climate, they developed a business model called integrated operations (IO) that sought to utilize technology to enable new ways of working through the integration of people, technology, process, and governance changes.

The Light Water Reactor Sustainability (LWRS) program, working with IFE have developed an operating model via transferable learnings from the North Sea oil and gas industry. This framework is termed Integrated Operations for Nuclear (ION). ION is a transformation model that integrates the benefits and features of four principal factors: people, technology, process, and governance.

The purpose of this report is to describe how to generate an ION business process analysis and utilize this information to reduce operations and maintenance costs. In order to make this job easier, the Department of Energy LWRS has created a suite of tools that will enable building a solid documented business case for supporting major transformation efforts. These tools, the Integrated Operations Capability Analysis Platform (ICAP) and the LWRS Innovation Portal, are described herein with instructions on their use. Instructions on how the interface with the Electric Power Research Institute business case analysis method are also provided.



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## ACRONYMS

API	application programming interface
BCAM	business case analysis model
BCMW	business case methodology workbook
DOE	Department of Energy
EPRI	Electric Power Research Institute
ICAP	Integrated Operations Capability Analysis Platform
IFE	Institute for Energy Technology
IO	integrated operations
ION	integrated operations for nuclear
IT	information technology
KPI	key performance indicator
LWRS	Light Water Reactor Sustainability
MHW	megawatt hour
O&M	operation and maintenance
PTPG	people, technology, processes, and governance
SQL	structured query language

# REPORT ON THE USE AND FUNCTION OF THE INTEGRATED OPERATIONS CAPABILITY ANALYSIS PLATFORM AND INNOVATION PORTAL

## 1. INTRODUCTION

The commercial nuclear power industry has achieved excellent safety and reliability performance but is struggling to survive in an electricity market that is increasingly dominated by subsidized renewables and cheap natural gas. These challenges have forced utilities to explore new ways to drastically reduce the operations and maintenance (O&M) costs of their plants which are the primary drivers of the total cost to produce electricity.

Parts of the petrochemical industry faced similar challenges some years ago as the costs of extraction and processing were rising while their reservoirs were being depleted in combination with decreased commodity prices, resulting in unsustainable operations. In this challenging climate, they developed a business model called integrated operations (IO) that sought to utilize technology to enable new ways of working through the integration of people, technology, process, and governance changes. IO also includes realizing the full potential of individual skills, capabilities, and creativity to work smarter not harder while seeking to streamline organizational structures and regulatory oversight. Figure 1 describes key concepts in implementing of IO that can have a profound impact on the way work is performed in the nuclear industry.

Traditional Way of Working	IO Way of Working
Serial	Parallel
Single discipline	Multi discipline
Dependence of physical location	Independent of physical location
Decisions made based on historical data	Decisions made based on real-time data
Reactive	Proactive

Figure 1. Integrated operations: a new way of working.

The United States (U.S.) Department of Energy (DOE) Light Water Reactor Sustainability (LWRS) program has an ongoing collaborative research agreement with the Institute for Energy Technology (IFE), a leading research laboratory in Norway, that has worked with the petrochemical industry to develop the integrated operations IO model. Working together with DOE, IFE developed a report outlining how the U.S. nuclear industry might adapt IO concepts for its own use (see reference 3). At the same time, the LWRS program began a collaborative project with a leading U.S. nuclear utility that was seeking a way to transform their business model to drive down costs while still achieving high-level safety and operational goals. The result of this effort was a transformative business model called Integrated Operations for Nuclear (ION).

ION is a new transformation model that integrates the benefits and features of four principal factors working together: people, technology, process, and governance. Many former business transformation efforts just focus on one or two of these factors and leave out the others. For example, some might believe that purchasing and installing an advanced software package or corporate business system will solve all of their problems. However, many, if not most, software upgrade projects fail due to a lack of consideration towards how the human interacts with the technology and how the organization might need to be changed for maximum impact. The same thing can be said for many business process re-engineering efforts that seek to just manipulate existing processes without understanding why the process exists or if it is needed at all.

Another distinctive feature of ION is that it is a transformative, step-changing model instead of an evolutionary model for changing the business. The U.S. nuclear industry has been on the path of gradual improvement over the last 20 years and has recently achieved the highest ever generation availability and also generated more megawatt hours (MWH) than ever before. However, even with O&M costs moderating slightly (Figure 2), other sources of energy are able to generate at lower costs, resulting in many nuclear plants being noncompetitive. It has been reported that some petrochemical companies have achieved a reduction of 30% in their O&M costs through applying the principles of integrated operations. In order for nuclear to survive in this current climate, an O&M cost reduction of over one third is necessary and is achievable through the application of ION.

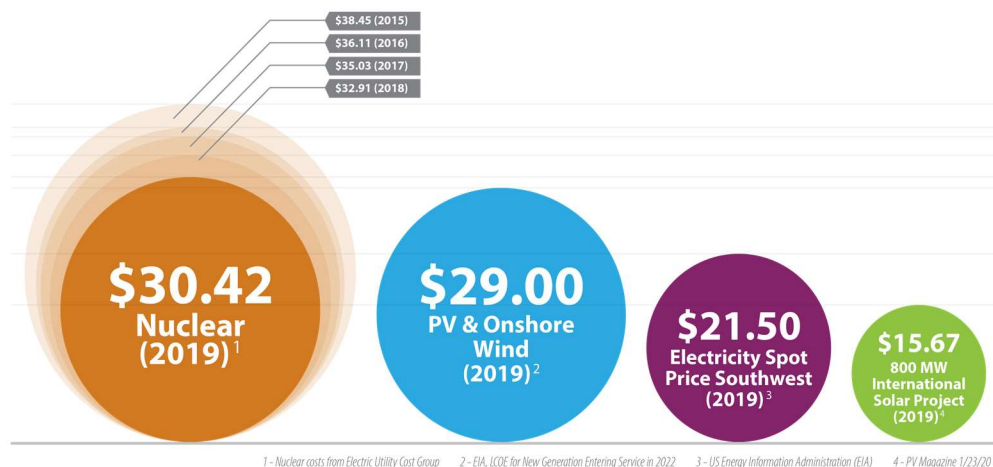


Figure 2. Comparing generating costs of electricity.

## 1.1 Purpose and Scope

The purpose of this report is to describe a suite of tools that can be used to generate an ION business process analysis and utilize this information to reduce O&M costs. Using these tools, companies can build a solid documented business case for embarking on major transformation efforts. The following are the components of the tool suite for ION (shown in Figure 3).

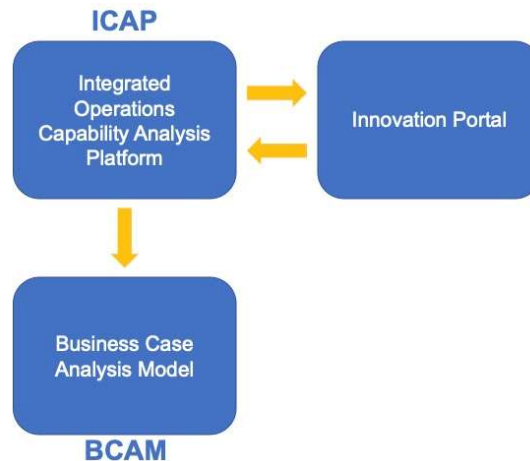


Figure 3. Relationship between ICAP, Innovation Portal, and BCAM.

### 1.1.1 Integrated Operations Capability Analysis Platform (ICAP)

The Integrated Operations Capability Analysis Platform (ICAP) is a software application that contains the data, structure, and results using the ION Capability Analysis framework to identify work reduction opportunities and eliminate duplication of work activities. The ICAP is designed to provide a direct interface to the Electric Power Research Institute (EPRI) business case analysis method (BCAM) for the development of detailed business cases for work reduction opportunities identified by the ICAP. See Section 2 for details on the functions and features of the ICAP.

### 1.1.2 Innovation Portal

The Innovation Portal is a web-based software program that serves as a resource catalog of advanced technologies, processes, methods, and ideas backed up by LWRP Program research and development. The Innovation Portal will also serve as a clearinghouse for technologies and processes already used by other utilities engaging in transformative efforts. Users will have the ability to view products, services, and concepts and obtain information on how to contact current users and suppliers. The Innovation Portal will be automatically linked to the ICAP so that users can seamlessly access advanced technology information while developing work reduction opportunities. The ICAP and Innovation Portal tools will be discussed at length in later sections of this report. See Section 3 for details on the functions and features of the Innovation Portal.

### 1.1.3 Business Case Analysis Model (BCAM)

The Business Case Analysis Model (BCAM) is an EPRI product based on an earlier development by the LWRP Program with ScottMadden Inc. It is an Excel based tool that allows users to perform work function analysis and develop business cases for process and technology innovation. Use of the BCAM is described in various EPRI reports and will not be further described in this report beyond its connection with the ICAP touched on in Sections 2.7 and 4.

## 1.2 Background: Integrated Operations for Nuclear and Capability Analysis

ION is a transformational business process model that seeks to integrate the full capabilities of people, technology, process, and governance to bring about a paradigm shift resulting in increasing value to the business. In the nuclear power world, much of the cost of O&M is tied up in manual labor without the benefit of modern technology. Through ION, technology can be applied in such a way as to reduce manual labor, increase real time information about the plant and equipment performance, enhance the human experience, and reduce total cost. Through this process, the management organization will need to be adjusted, and regulatory barriers to innovation may need to be resolved.

Thus, in order to build a transformed business model based on ION, this new way of working needs to be translated into concrete action steps for careful implementation. ION is about utilizing the whole suite of resources across the four dimensions of people, technology, process, and governance, as well as integrating them into a fundamentally different business model. Figure 4 illustrates how ION is implemented across the four key fundamental business areas.

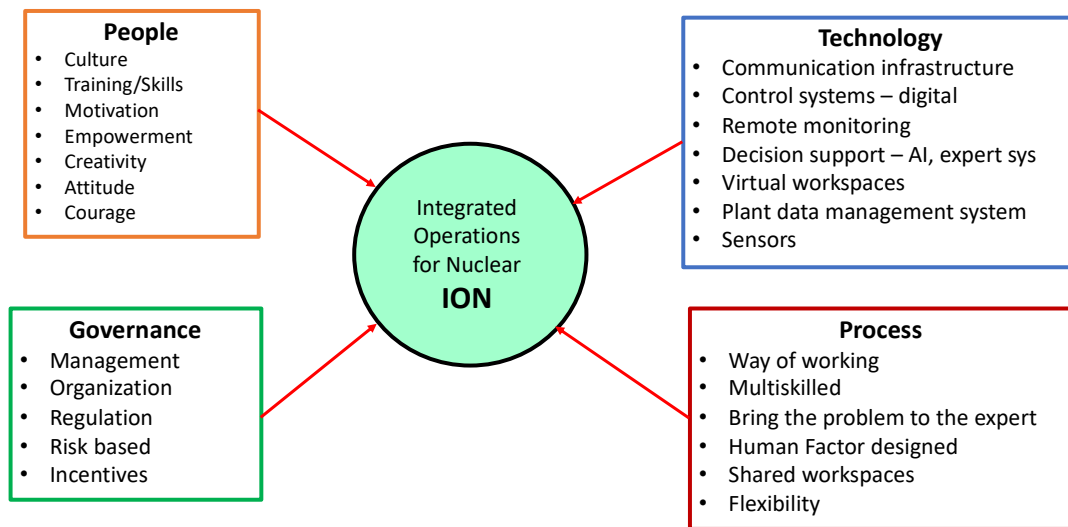


Figure 4. ION: the integration of people, technology, processes, and governance (PTPG).

Understanding and evaluating the current work processes and governance structures across the four dimensions of people, technology, process, and governance is not an easy exercise when embarking upon a company transformation. Many times, companies focus on just changing the technology or adding a new system or process without addressing the other factors of personnel or governance. It is not surprising that most of these efforts fall drastically short of expectations and sometimes even result in a less efficient and more expensive operation.

Capability assessment is an important way to address the primary people, technology, process, and governance factors all together to arrive at a business solution that adds value to the operation. According to the IO Handbook (Reegard et al., 2014): *“The Capability Approach to IO is an approach for systematically managing the increasing complexity IO projects through structured development of the key resources needed for realizations of the value of IO opportunities.”*

In order to understand and utilize the capability approach, what constitutes a capability must first be understood. Also, from the Reegard and colleagues (2014): *“A capability is the synthesis of people, processes, governance/organization and technology which constitute the building blocks for delivering the intended performance.”*

When implementing ION, one of the key activities is to develop a set of capabilities necessary for the nuclear facility to function successfully and provide electricity at a competitive price point. It may be helpful here to provide an example of what we mean by capability development. If, for instance, a trip to Mars to start a permanent colony was planned, the ability to grow food would be required (among other things). In this example, the capabilities required to accomplish this mission could look like this (Figure 5):



Figure 5. Capabilities for food production

However, given that there will likely be many people involved in the production of food, some sort of organizational structure will be required to keep the operation going and there are no resources that can be wasted—everything must be as efficient as possible. So, if the necessary support capabilities are added to Figure 5, the result is shown in Figure 6:



Figure 6. Capabilities and support capabilities for food production.

However, one more thing is necessary for consideration to get a full picture of what is necessary to accomplish the mission of sustainable food production. The equipment, structures, control systems, electric generation, and information technology (IT) platform and sensors must be included in the IO model and capability assessment in order to get a full and complete picture of what capabilities are truly required. If foundational capabilities are added, the result is shown in Figure 7:



Figure 7. Capabilities, support capabilities, and foundation capabilities for food production.



Figure 7 is termed a capability stack, and it represents the starting point for any capability assessment. As can be seen, all the capabilities must work together and support one another in order for the goal to be accomplished. For example, in order to execute the capability to grow food, each support capability must provide the necessary function to carry out that objective. In addition, the foundational capabilities are critical to carry out the mission, as very specific equipment will be required to enable the capability to grow food.

The LWRS program, working in collaboration with Xcel Energy, developed a stack model for a three-unit nuclear operation located at two sites (Figure 8). The stack model presented here is thought to be representative of a transformed operating model based on IO principles and concepts. It is further thought to be somewhat universal since all operating nuclear plants are involved with these basic functions (with the exception of Hybrid Energy).

This model will form the basis for analyzing the work functions for each capability and support capability and then identifying work reduction opportunities resulting from new technologies, process changes, or regulatory reform. This process will be described in the next section of this report.

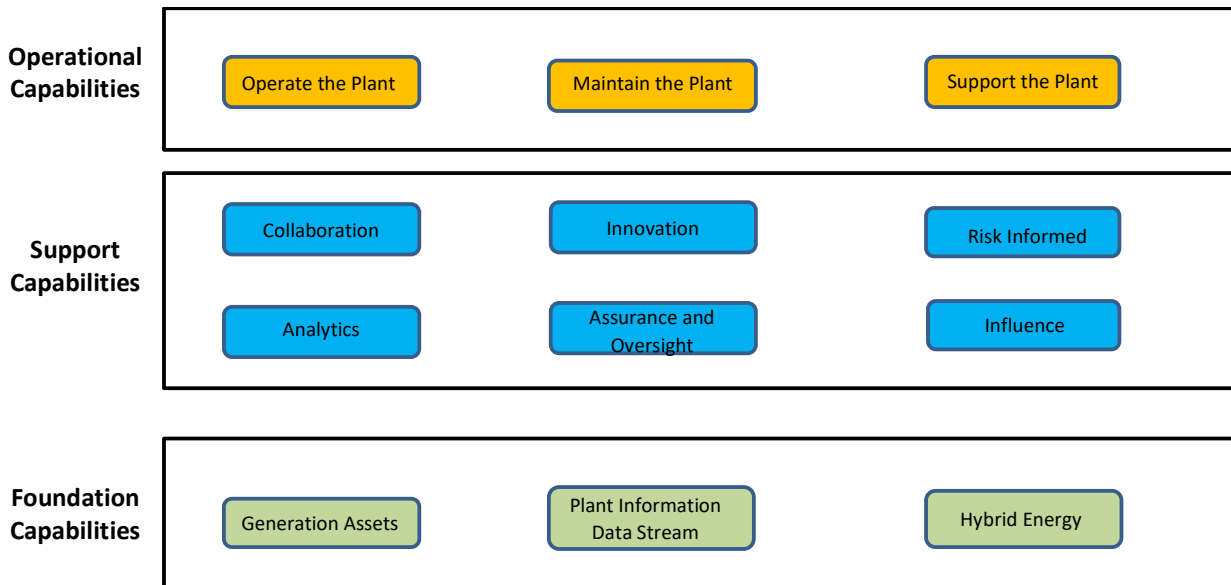


Figure 8. Example nuclear capability stack model.

## 2. INTEGRATED OPERATIONS CAPABILITY ANALYSIS PLATFORM

### 2.1 Purpose of the ICAP

The ION framework is a business-driven approach for transforming the operating model of a commercial nuclear plant from one that is manual labor-centric to one that is technology-centric, using a top-down/bottom-up process as follows:

- *Top Down Process.* A market-based price point (typically bus-bar cost in dollars per MWH) for nuclear generation is set and then used to back out what the maximum total O&M budget of the nuclear fleet can be to support this price. This budget in turn is allocated over the nuclear organization in a top-down manner as the starting point of an iterative process.
- *Bottom Up Process.* Work functions are analyzed for aggressive opportunities to reduce workload to that which is essential and can be resourced within this O&M budget.
- *Integrating these Processes.* The streamlined work functions are then configured into a transformed operating model that leverages advanced technology and process innovations, resulting in a small on-site staff focused on daily operations with all maintenance and support functions centralized or outsourced in on-demand service models.

The ICAP accomplishes its purpose through a structured multilayer approach. That is, the ICAP enables performing a top-down analysis at the organizational level that sets a common goal of achieving the future state cost-of-business objectives. Next, opportunities are analyzed at the work function level, such as by examining current costs, current use of technology, governance and legal requirements, and key performance indicators (KPIs). Finally, work reduction opportunities are analyzed through selected cost reduction plans, which are characterized by their technology dependencies, feasibility, risk factors, and expected cost savings. Where practical, these work reduction opportunities can then be aggregated up the organization to realize synergistic cost savings (i.e., bottom-up analysis). The combination of top-down and bottom-up analyses are seen in Figure 9, which shows the top-down progression from capabilities, to sub-capabilities, to work functions, and to work reduction opportunities. Figure 9 also shows the bottom-up aggregation of savings from individual work reduction opportunities when rolled up across their impact to the people, processes, technology, and governance.

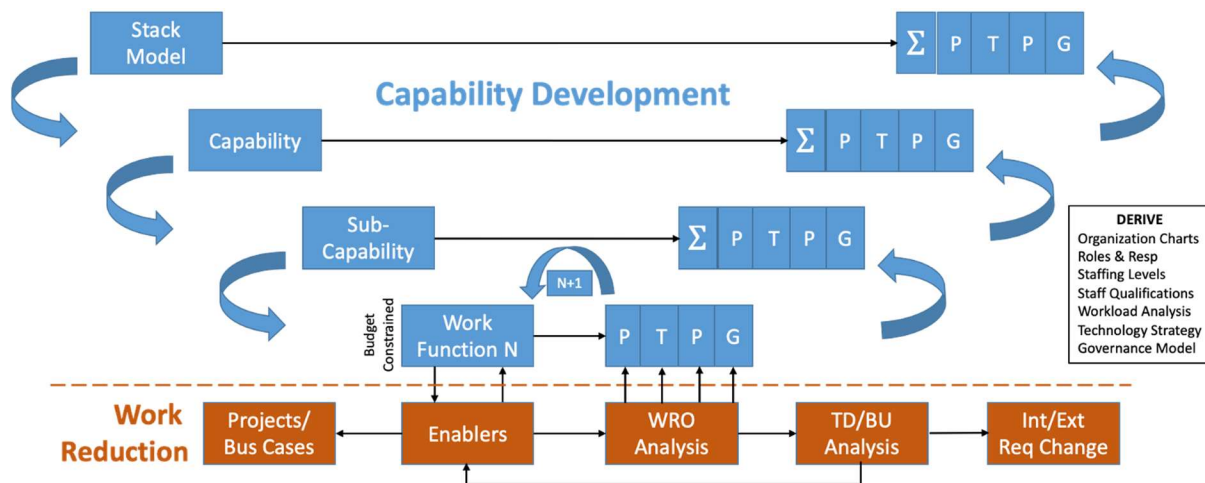


Figure 9. Capability assessment framework.

The ICAP is also linked to two important tools: the BCAM and the Innovation Portal. The data collected in the ICAP can be used in the BCAM to develop detailed business cases. Further, the Innovation Portal can be leveraged for technology requirements gathering for each work reduction opportunity through easy access to the portal.

The ICAP drives three important outcomes:

1. It ensures that all work/process changes, technology deployments, and organizational changes have a direct tie to achieving the future state cost-of-business objectives.
2. It provides a quantitative basis for ensuring that the cost of performing work functions in the future can be accomplished within the allocated budget of the organization owning those work functions.
3. It provides a means of aggregating the business cases (quantified benefits compared to investment costs) across all the work functions that will benefit from common work reduction opportunities, such as requirements changes, technology deployments, and process improvements.

## **2.2 ICAP Features**

The ICAP provides four featured tools and two supporting tools to support a work function analysis. Primarily, the ICAP's four featured tools follow the multilayer structure described in ION; that is, the ICAP tool enables developing capabilities, followed by sub-capabilities, followed by work functions, and finally work reduction opportunities. At the work reduction opportunity level, cost reductions can be described in relation to their technology dependencies, feasibility, risk factors, and expected return on investment. The capability stack model framework here can be mapped to the organization and tracked through managing organizations and indicators, respectively.

## **2.3 Using the ICAP**

The capability tools and support data tools with their associated features and functions are accessed from the home page (Figure 10). The user can access any given tool by selecting the 'Launch Tool' button. Once selected, the ICAP takes the user to the intended tool's primary page. The supporting data tools are described further in Section 2.4 and the featured tools are described further in Section 2.5, respectively.

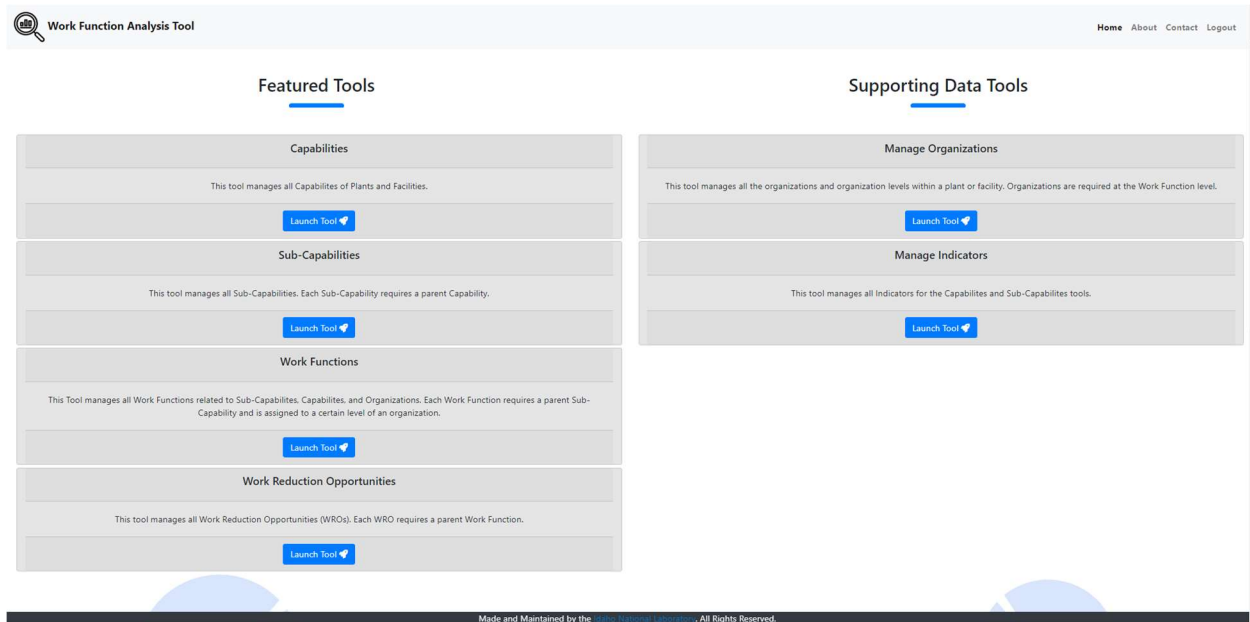


Figure 10. Home page for ICAP.

## 2.4 Supporting Tools for Capabilities Assessment

### 2.4.1 Organizational Analysis

The purpose of the organizational analysis under Manage Organizations is to develop the structure of the organization from within the utility so that work functions can be effectively mapped. That is, it is realized that work functions can be mapped to different organizational levels. By creating the hierarchy of organizations and levels within the ICAP, the tool enables the mapping of the organization to specific work functions, described later in this report.

Figure 11 shows the first page that the user will see when specifying organizational levels. The user can view organizations at different levels through the dropdown widgets (Figure 11). Organizations can be modified and added through the Manage Organization button once a level is specified from the dropdown. When selected, a modal window will appear with a table of existing organizations for a given level (Figure 12). The user can modify an existing organization by selecting it from the table and editing from a second modal window. The user can also add a new organization by selecting the '+Add' button. The second modal window will appear to allow the user to enter metadata about the new organization. Here, the user can specify its level, its name, an associated parent organization (if greater than level 1), and a description of the organization. Once making a modification or adding a new organization, the user will select 'Save' to submit the entry into the database. The user can cancel an entry or modification at any time by selecting the 'x' button on the top right of the modal window or by selecting 'Cancel.'

## Tools | Manage Organizations

← Back

Level:

Select Org Level

Organization:

Select Organization

Manage  
Organizations

**i** Please Select a Level and an associated organization from the available dropdown menus. If none are available, create one by selecting the "Manage Organizations" button.

Figure 11. Manage organizations page.

The screenshot shows the 'Tools | Manage Organizations' page. A modal window titled 'Org Details' is open, allowing the user to add a new organization. The modal contains the following fields:

- Org Level: A dropdown menu with '1' selected.
- Organization Title: A text input field.
- Parent Organization: A dropdown menu with 'Select Parent Org' selected.
- Org Description: A text area.

At the bottom of the modal are 'Cancel' and 'Save' buttons. In the background, the main page shows a 'Level' dropdown with 'Level 1' selected, an 'Organization' dropdown with 'Select Organization' selected, and a 'Manage Organizations' button. A message at the top of the page reads: 'Please Select a Level and an associated organization from the available dropdown menus. If none are available, create one by selecting the "Manage Organizations" button.'

Figure 12. Adding an organization from the manage organizations page.

### 2.4.2 Key Performance Indicators

As the operating model transforms to adopt ION principles, it is important to establish Key Performance Indicators (KPIs) to measure the performance of processes and systems, track the progress of the transition to the ION model, and improve accountability and ownership. These KPIs can be added to Capabilities, Sub-Capabilities, and Work Functions as necessary. Using a tiered hierarchy of KPIs with varying levels of granularity and different audiences/owners is necessary for proper accountability and process change. For example, high-level KPIs would capture long-term performance across the fleet and indicate the overall health of the individual nuclear plants and nuclear fleet. Lower level KPIs become more plant, department, or system dependent and would be reported more frequently to lower levels of the organization.

Figure 13 shows the initial page the user will see when selecting the 'Manage Indicators' tool from the home page. There are two key fields. The 'Tier' dropdown allows the user to select what level in the hierarchy the KPI maps to (i.e., using a three-tiered structure). Once the tier is selected, the user can specify the type of indicator from the second conditional dropdown. The user can modify an existing KPI's metadata by selecting 'Manage Indicators.' Once selected, an existing KPI can be selected from the table in a modal window (see Figure 14). A second modal window will appear, allowing the user to modify content. The user can also add a new KPI by selecting the '+Add' button and completing the fields in the second modal window (as seen in Figure 14). Once making a modification or adding a new KPI, the user can select 'Save.' Once started, cancelling the addition or modification of a KPI can be accomplished by selecting the 'x' button on the top right of then modal window or by selecting 'Cancel.'

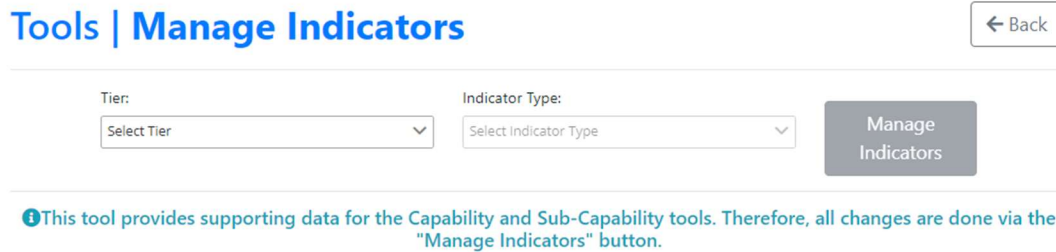


Figure 13. Manage indicators page.

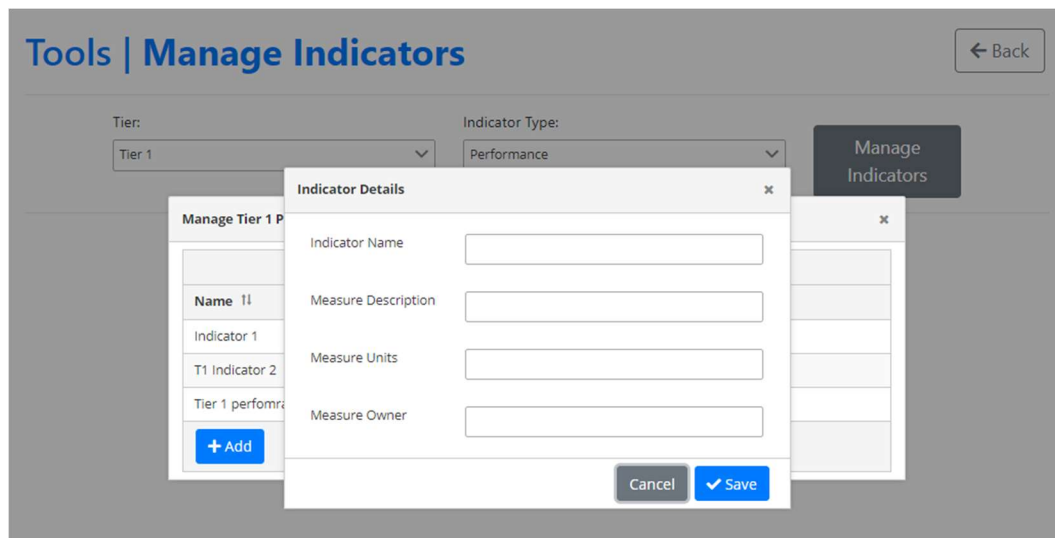


Figure 14. Adding an indicator from the manage indicators page.

## 2.5 Capabilities Assessment

The purpose of the capabilities assessment is to effectively reduce O&M costs through a comprehensive approach that focuses on identifying and eliminating organizational silos that impede a cost-effective business strategy. The capabilities assessment is a primary function in the framework of capability thinking and can be considered complementary to the fundamental philosophy of IO (INL/EXT-20-59537). Specifically, a capabilities assessment broadly accounts for the way in which O&M cost reductions can be realized through comprehensively considering the influence on people, processes, technology, and governance (i.e., organization), as seen in Figure 15.

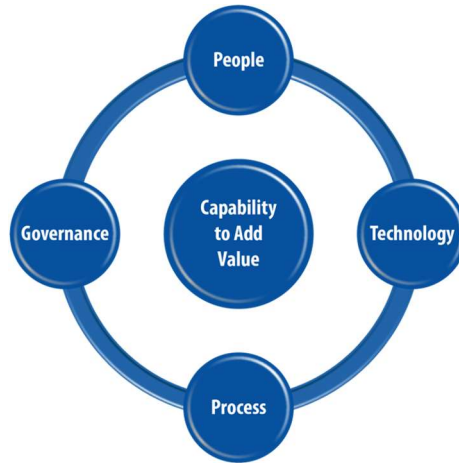


Figure 15. Capability framework comprises the synthesis of people, processes, technology, and governance.

The ICAP allows a user to engage in capabilities assessment at each hierarchical layer of the capabilities model: by capabilities, by sub-capabilities, by work functions, and by work reduction opportunities. Figure 16 below shows the menu option of ICAP that supports each of these layers. A description of their key features and functions are described next.

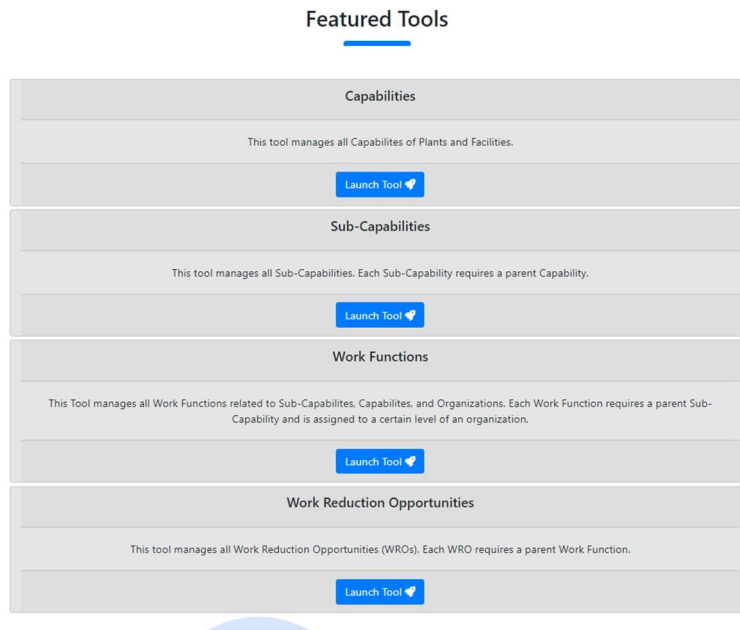


Figure 16. Capabilities assessment tabs on home page.

## 2.5.1 Capabilities Tab

At the top of the hierarchy, the 'Manage Capabilities' tool allows a user to view and modify specific content for a created capability or manage (e.g., add or remove) capabilities. Both options are provided upon selecting 'Launch Tool' under the Manage Capabilities pane on the home page (see Figure 16).

### 2.5.1.1 Viewing or modifying content for an existing capability

To view or modify content for an existing capability, a dropdown widget is provided (see Figure 17). Here, the user is able to select a capability from the defined list or can begin entering a keyword in an

embedded search menu. The search capability allows for partial string match to ensure that the user's query casts broadly across possible list items.

The screenshot shows the 'Tools | Manage Capabilities' page. At the top, there is a navigation bar with 'Home', 'About', 'Contact', and 'Logout'. Below this, the page title 'Tools | Manage Capabilities' is displayed. A 'Back' button is located to the right of the title. The main content area features a 'Capability:' label above a search input field. The input field has a dropdown arrow and a magnifying glass icon. A dropdown menu is open, showing a list of capabilities: 'AD | Adaptability', 'AN | Analytics', 'AS | Assurance', 'CO | Collaboration', 'IF | Influence', and 'IN | Innovation'. To the right of the search input is a 'Manage Capabilities' button. Below the dropdown menu, the word 'Capability' is written in blue.

Figure 17. Selecting an existing capability.

A detailed page is provided for the given capability upon selecting a created capability (see Figure 18). Here, the user can enter a description of the new capability as well as the impact it has from a people, processes, technology, and governance perspective. These fields are open text fields to allow for rich contextual data to be entered. Once entered, data can be saved in a database by selecting 'Save Changes.'

The screenshot shows the 'Tools | Manage Capabilities' page with the 'AS | Assurance' capability selected in the dropdown menu. The 'Manage Capabilities' button is still visible. Below the dropdown menu, the text 'AS | Assurance' is displayed in blue. The main content area contains three text input fields labeled 'Description:', 'Process:', and 'Technology:'. Below these fields is a blue 'Save Changes' button. At the bottom of the page, there is a footer with the URL 'https://wfa-tool.int.gov/it/' and the copyright notice '© 2020 Work Function Analysis. All Rights Reserved.'

Figure 18. Entering and viewing data for a specific capability.

### 2.5.1.2 Managing capabilities: adding a new capability

Capabilities can be added or removed by selecting 'Manage Capabilities' (refer to Figure 17). When selected, a modal window is displayed that presents a table of capabilities previously entered. The table outlines the metadata of the capability, including its name, a two-character code name, assignment to a plant function (e.g., operate, maintain, or support), and any comments about the capability. A new capability can be added by selecting the '+Add' button where a second modal window appears that allows a user to enter tabular data of the new capability to be stored in the ICAP database (see Figure 19).



The screenshot displays a web application interface for 'Work Function Analysis'. The main header includes 'Home', 'About', 'Contact', and 'Logout'. The page title is 'Tools | Manage Capabilities'. A modal window titled 'Functional Area Details' is open, allowing the user to add a new capability. The modal contains the following fields:

- Capability Name \***: A text input field.
- Capability Code \***: A text input field with a red warning message 'Max 2 characters' below it.
- Plant Function \***: A dropdown menu currently showing 'Select Plant Function'.
- Comments**: A large text area for freeform entry.

At the bottom of the modal are 'Cancel' and 'Save' buttons. The background shows a table of 'Current Capabilities' with a search bar and an '+ Add' button at the bottom left.

Figure 19. Adding a new capability.

Capability name and code are presented as entry fields to allow for a degree of flexibility in entry. Plant function is provided as a dropdown widget to ensure consistent assignment from capability to specified, likely predefined, plant functions. Comments can be entered freeform in a large text field as needed; this optional field is provided before selecting 'Save' to add the new capability into the ICAP database. The user can cancel adding a capability by closing out of the modal window using the standard 'x' button on the top right of the window or via 'Cancel.'

#### **2.5.1.3 Managing capabilities: modifying or deleting an existing capability**

The user can modify or delete an existing capability by selecting 'Manage Capabilities' (refer to Figure 17). From the table of capabilities in the modal window, the capability of interest can be selected to open a second modal window with the descriptive information (i.e., metadata) of the capability, such as its name, code, plant function, and any comments (see Figure 20).

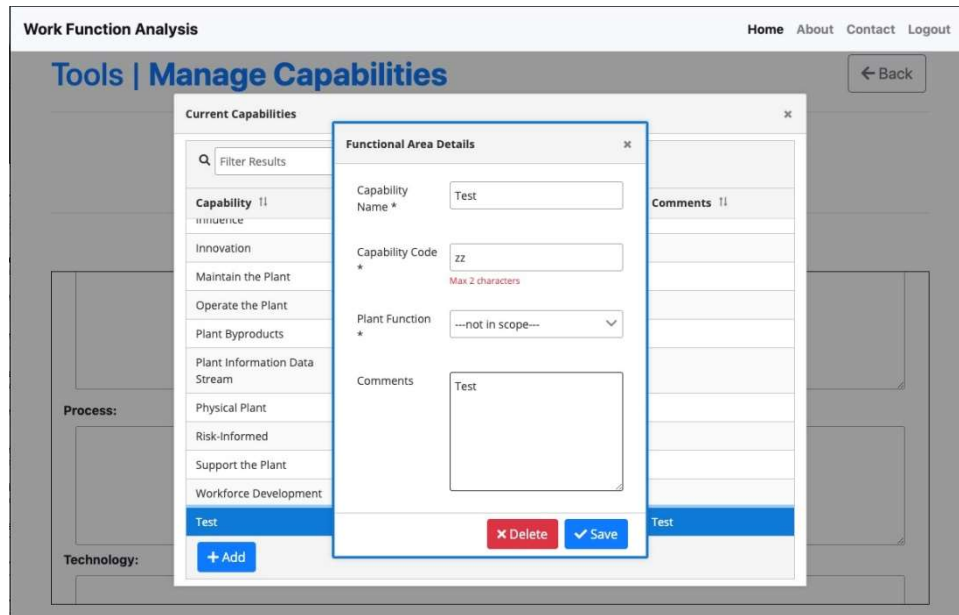


Figure 20. Modifying or deleting a capability.

A capability's metadata can be modified by changing the intended content directly from the modal window (e.g., modify the name by changing the existing name) and selecting 'Save.' A capability can be deleted by selecting the red 'Delete' button.

## 2.5.2 Sub-Capabilities Tab

The sub-capabilities functionality is accessed similar to capabilities. From the home page, the user can select 'Launch Tool' from the 'Manage Sub-Capabilities' pane (see Figure 16).

### 2.5.2.1 Viewing or modifying content for an existing sub-capability

There are two dropdown widgets with querying capability provided to view or modify content for an existing sub-capability (Figure 21). The first dropdown serves as a conditional picklist for the second dropdown. Here, the user selects a capability from the leftmost dropdown, which dynamically updates the content in the second dropdown that contains the sub-capability of interest. This structure fits the hierarchal relationship between capabilities and sub-capabilities (i.e., sub-capabilities reside within a given capability).

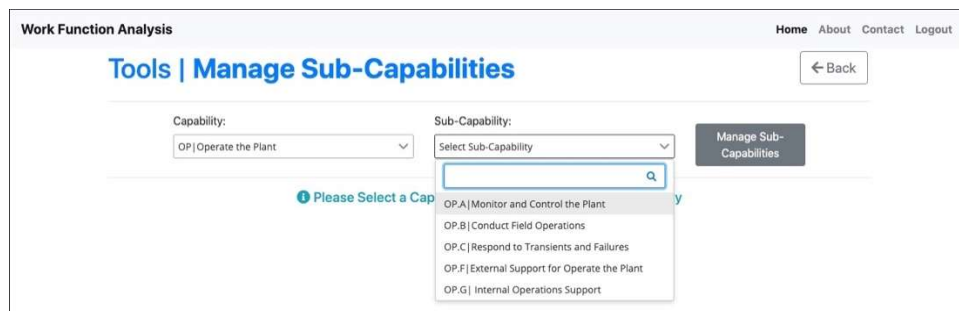


Figure 21. Selecting an existing sub-capability.

A detailed page is provided for the given sub-capability upon selection (see Figure 22). This form contains the same open text data fields as capabilities: a description as well as the impact it has on the

people, processes, technology, and governance perspective. Data can be saved in a database by selecting ‘Save Changes.’

Work Function Analysis

Home About Contact Logout

Tools | Manage Sub-Capabilities

← Back

Capability: OP | Operate the Plant

Sub-Capability: OP.C | Respond to Transients and Failures

Manage Sub-Capabilities

OP.C | Respond to Transients and Failures

Description:

Machine learning and AI will be used in addition to real time communication to remove the burden of diagnosis from the operators. Initiating events will be analyzed and diagnosed by the machine, which will guide the operators response.

Process:

The ERO will need to be trained on how to query the new system and how to interpret and validate the results prior to applying the recommendations. The will include table tops and drills with all ED and EM personnel also with other ERO personnel involve with classification and PAR recommendations. This will require significant development, validation, piloting on a small set of procedures then expanding to the full set. Once the system and associated recommendations have been validated, there will be an extensive effort to retrain licensed operators on the new methods for EOP use. This training will occur in the Simulator.

This will require training for licensed and non-licensed operator on how to use the electronic ARP and how to override the automated process when it is malfunctioning.

Technology:

The personnel involved in the Emergency Response facilities should be evaluated to determine if fewer people can be used. This will be based on the capability and accuracy of the AI.

Save Changes

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Figure 22. Entering and viewing data for a specific sub-capability.

### 2.5.2.2 Managing sub-capabilities: adding a new sub-capability

Sub-capabilities can be added by selecting ‘Manage Sub-Capabilities’ (refer to Figure 21). Selecting ‘Manage Sub-Capabilities’ will open a modal window that presents the sub-capabilities available for a given capability in a table format. The user can add a new sub-capability by selecting the ‘+Add’ button. Once selected, a second modal window will appear to allow the user to populate metadata for a new sub-capability (see Figure 23).

Work Function Analysis

Home About Contact Logout

Tools | Manage Sub-Capabilities

← Back

Capability: OP | Operate the Plant

Sub-Capability: Select Sub-Capability

Manage Sub-Capabilities

Current Operate the Plant Sub-Capabilities

Sub-Capability	Sub-Capability Name	Sub-Capability Code	Comments
Monitor and Control			
Conduct Field Operations			
Respond to Transients			
External Support			
Internal Operations			

+ Add

Sub-Capability Details

Sub-Capability Name

Sub-Capability Code

Comments

Cancel Save

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Figure 23. Adding a new sub-capability.

The sub-capability's name and code are presented as entry fields. Comments can be entered freeform in a large text field as needed. The user then can submit the new entry by selecting 'Save' to add the new sub-capability into the database. The user can cancel the entry by closing out of the modal window through the standard 'x' button on the top right of the window or via 'Cancel' button.

### 2.5.2.3 Managing sub-capabilities: modifying or deleting an existing sub-capability

Within a given capability, an existing sub-capability's metadata can be modified or deleted by first selecting 'Manage Sub-Capabilities' (refer to Figure 21) and then selecting the sub-capability of interest from the table in the modal window. From the table, the user can select a sub-capability and modify its metadata including its name, code, or comment from the second modal window. The user will select 'Save' to submit modifications. A sub-capability can be deleted by selecting the red 'Delete' button from this second modal window.

## 2.5.3 Work Function Tab

Work functions are the third level in the capabilities assessment hierarchy. Work functions are the actual process steps used to perform tasks or activities. It is at this level where work reduction opportunities can be identified, or work steps eliminated. It is also at this level where actual time spent on the task can be collected and analyzed for efficiency improvements. It is important to note that work functions can be associated with organizational levels for the purpose of analysis. Work functions are accessed via the 'Launch Tool' from the 'Manage Work Functions' pane, as shown back in Figure 16. Here, the user is able to view existing work functions, add new work functions, or modify/ delete work functions.

### 2.5.3.1 Viewing or modifying content for an existing work function

A user can view or modify content in an existing work function by selecting it from a dropdown picklist (see Figure 24). Work functions are nested within sub-capabilities, so the user will need to first select a capability from the leftmost dropdown, then select a sub-capability within that given capability, and, finally, select a work function from the selected sub-capability. Users can use a partial string match to search for each dropdown picklist as needed.

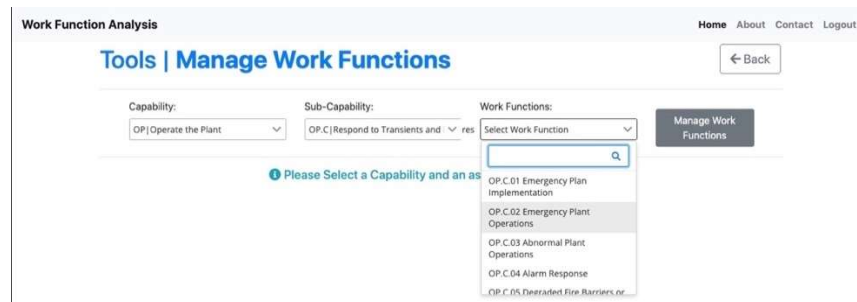


Figure 24. Selecting an existing work function.

The detailed work function page provides a series of unique data fields that can be viewed or modified (Figure 25). Within a given work function, there is a dropdown that enables mapping to an associated organization level and organization for a given utility. By mapping work functions to specific organizations and associated levels, collective benefits can be realized across different organizations for any given work function when looking at specific work reduction opportunities. This supports the developing business cases for any given work reduction opportunity across multiple organizations and levels.

The work functions page also provides text fields for a description, utility requirements, KPIs key performance indicators, and the impact it has on people, processes, technology, and governance. Data can be saved into the database through the tools standard convention of selecting ‘Save Changes.’

Figure 25. Entering and viewing data for a specific work function.

### **2.5.3.2 Managing work functions: adding a new work function**

Work functions can be added by first selecting ‘Manage Work Functions’ and then selecting the ‘+Add’ button from the modal window. The user can then enter metadata about the new work function in a second modal window; this workflow is consistent with the workflow for capabilities and sub-capabilities.

### **2.5.3.3 Managing work functions: modifying or deleting an existing work function**

The metadata for an existing work function can be modified by first selecting ‘Manage Work Functions’ and then selecting an existing work function from the table in the modal window (see Figure 26). Metadata for a given work function include ‘Work Function Id’ and ‘Work Function Description.’ The user will select ‘Save’ to submit modifications to the work function’s metadata. A work function can be deleted by selecting the red ‘Delete’ button.

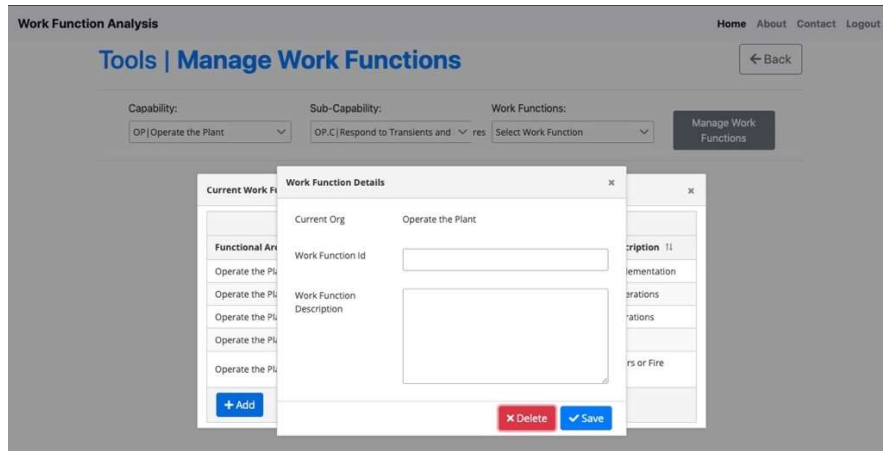


Figure 26. Modifying or deleting a work function.

## 2.5.4 Work Reduction Opportunity Tab

The Work Reduction Opportunity (WRO) tab is the most detailed level of the capabilities assessment hierarchy. The WRO provides a means of describing how the effort of a given Work Function can be reduced and by how much. This section contains the necessary information tabs to describe the concept, describe the technology it depends on, assess the risk, and capture the labor and non-labor savings. This is integral to the Top-Down/Bottom Up budget analysis. If required, business cases can be assembled across organizations to justify and support business transformation. Figure 27 illustrates the nested structure of the capabilities assessment in its entirety. Each work reduction opportunity comprises key information that is used to assemble business cases that reach across organizations. Here, enabling technology can be identified and selected to support the people and processes of each transformational opportunity. Further, detailed cost-benefit analyses can be supported for a given business case through directly linking information entered from the work reduction opportunity forms to the BCAM (described in Section 2.7).

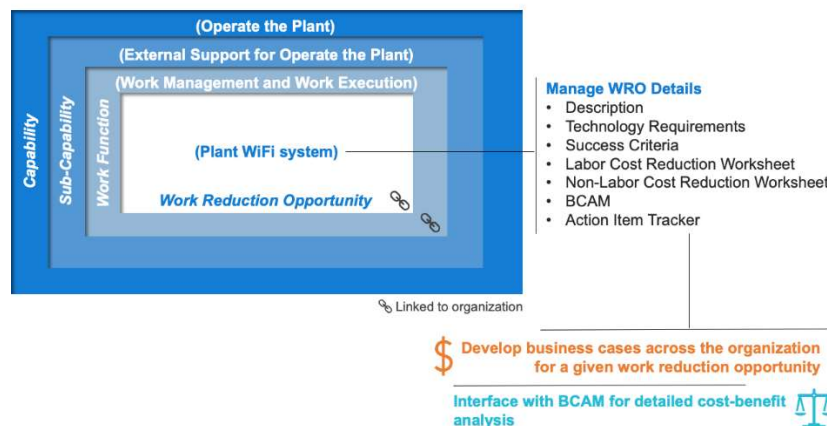


Figure 27. Nested structure of the capabilities assessment and work reduction opportunity features.

### 2.5.4.1 Viewing or modifying content for an existing work reduction opportunity

Users can access the work reduction opportunities page by navigating down the capabilities assessment hierarchy through four dropdown lists (see Figure 28).

Work Function Analysis

Home About Contact Logout

## Tools | Manage WRO Details

← Back

Capability: OP | Operate the Plant

Sub-Capability: OP.F | External Support for Operate the Plant

Work Functions: OP.F.01 Work Management and Work Execution

Work Reduction Opportunity: Select WRO

OP.F.01.01: Plant WiFi system

OP.F.01.02: Instrumented Plant Components

OP.F.01.03: Portable Electronic Interface Devices

OP.F.01.04: Virtual Equipment Technical Support available

OP.F.01.05: Intelligent Work Control System

Manage WROs

Please select a

Figure 28. Selecting an existing work reduction opportunity.

A detailed page is provided for the given capability upon selecting a created capability (see Figure 18). Here, the user can enter a description of the new capability, as well as the impact it has from a people, processes, technology, and governance perspective. These fields are open text fields to allow rich contextual data to be entered. Once entered, data can be saved in a database by selecting ‘Save Changes.’ The following sub-sections describe key pages that are part of a given work reduction opportunity.

### Description Page

The description page provides high-level information of the work reduction opportunity, including a dropdown to specify the type of reduction and a description of it using a text field (see Figure 29). Data can be modified by directly changing content from these fields and selecting ‘Save Changes.’

## Tools | Manage WRO Details

← Back

Capability: TS | Test

Sub-Capability: TS.01 | TEST

Work Functions: TS.01.A Test

Work Reduction Opportunity: TS.01.A.01: Test

Manage WROs

Description Technology Requirements Success Criteria Labor Cost Reduction Worksheet Non-Labor Cost Reduction Worksheet BCM Task Builder Action Item Tracker

Work Reduction Type: Select Reduction Type

Work Reduction Opportunity Description:

test

Save Changes

Figure 29. Work reduction opportunity description page.

## Technology Requirements Page

The technology requirements page provides a way of mapping enabling technology that will be used to support the work reduction opportunity (see Figure 30). The user can select technologies from a dropdown and provide a description in a text field. There can be a many-to-one relationship between the technologies and a work reduction opportunity. In this case, the user can add more technology selections via the green ‘+’ button, which will create a new dropdown/text field combination. Data can be modified by directly changing content from these fields and selecting ‘Save Changes.’ Technologies can be removed via the red trashcan button.

The screenshot displays the 'Technology Requirements' page. At the top, there are four dropdown menus: 'Capability:' (selected: TS|Test), 'Sub-Capability:' (selected: TS.01|TEST), 'Work Functions:' (selected: TS.01.A Test), and 'Work Reduction Opportunity:' (selected: TS.01.A.01: Test). To the right of these is a 'Manage WROs' button. Below these is a tabbed interface with tabs: 'Description', 'Technology Requirements' (active), 'Success Criteria', 'Labor Cost Reduction Worksheet', 'Non-Labor Cost Reduction Worksheet', 'BCM Task Builder', and 'Action Item Tracker'. The 'Technology Requirements' tab shows a list of two items. The first item is 'Computer-Based Procedures' with a dropdown arrow, a text field containing 'test', and a red trashcan icon. The second item is 'Smart Work Packages' with a dropdown arrow, a text field containing 'test 2', and a red trashcan icon. A green '+' button is at the bottom left, and a blue 'Save Changes' button is at the bottom right. A tooltip 'Learn More about Computer Based Procedures' is visible next to the first item's trashcan icon.

Figure 30. Work reduction opportunity technology requirements page.



## Success Criteria Page

The success criteria page provides a method to document, at a high level, the degree of success in implementing the work reduction opportunity (see Figure 31). This page captures the following fields: probability for successful implementation, level of difficulty, qualitative risk level, timeline, and additional notes. The first four fields are captured as a dropdown menu; the additional note is provided as a text field to enter notes. Data can be modified by directly changing content from these fields and selecting ‘Save Changes.’

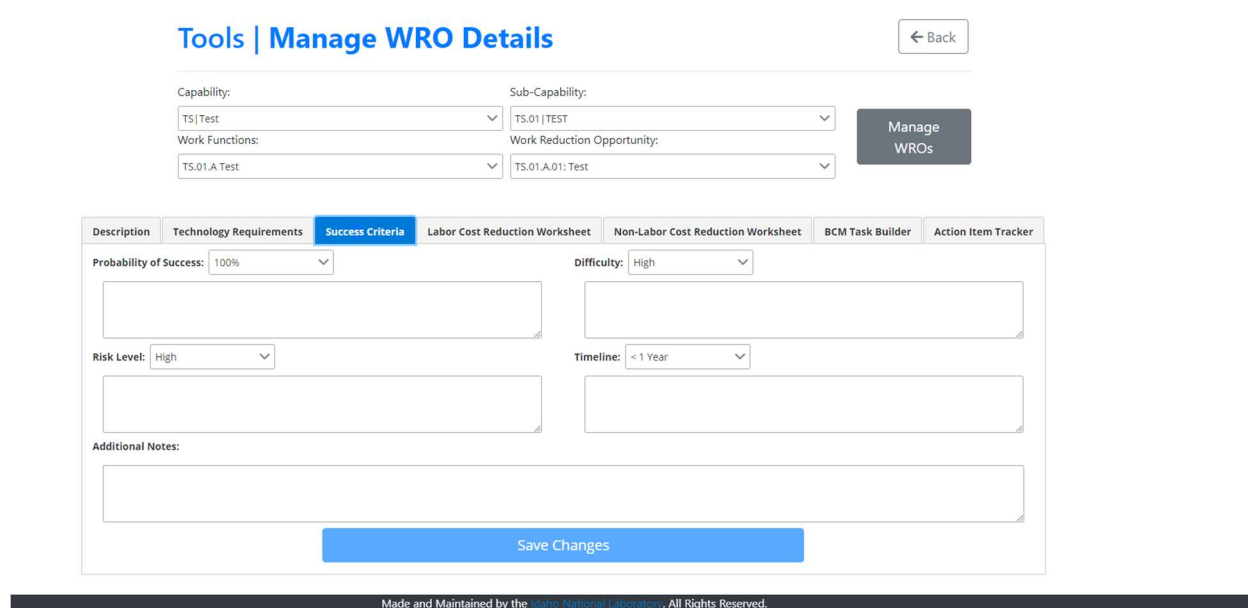


Figure 31. Work reduction opportunity success criteria page.

## Labor Cost Reduction Worksheet Page

The labor cost reduction worksheet page provides a method to document the total estimated labor savings upon implementing the work reduction opportunity (see Figure 32). There is a field to enter a basis for labor cost reductions followed by a table that includes the resource type, activity description, labor savings, resource rate, calculated savings, and labor savings scribed. Data entered into the table is done by selecting the ‘+Add’ button to enable a modal window to appear (see Figure 33). From this modal window, the user can enter cost reduction data for the work reduction opportunity and select ‘Save.’ Further, the user can remove data by selecting the data row (e.g., indicating resource) and then selecting the red ‘Delete’ button from the modal window.

Tools | Manage WRO Details

← Back

Capability:

TS|Test

Sub-Capability:

TS.01|TEST

Work Functions:

TS.01.A Test

Work Reduction Opportunity:

TS.01.A.01: Test

Manage WROs

DescriptionTechnology RequirementsSuccess CriteriaLabor Cost Reduction WorksheetNon-Labor Cost Reduction WorksheetBCM Task BuilderAction Item Tracker

Basis for Labor Cost Reduction:

Labor Saving Opportunities

Resource Type	Activity Description	Labor Savings (Hrs)	Resource Rate (\$/Hr)	Labor Savings Calculated (\$)	Labor Savings Scribed (\$)
Totals				\$ 0	\$ 0

+ Add

Figure 32. Work reduction opportunity labor cost reduction worksheet page.

Tools | Manage WRO Details

← Back

Capability:

TS|Test

Sub-Capability:

TS.01|TEST

Work Functions:

TS.01.A Test

Work Reduction Opportunity:

TS.01.A.01: Test

Manage WROs

DescriptionTechnology RequirementsSuccess CriteriaLabor Cost Reduction WorksheetNon-Labor Cost Reduction WorksheetBCM Task BuilderAction Item Tracker

Basis for Labor Cost Reduction:

Labor Saving Opportunities

Resource Type	Activity Description	Labor Savings (Hrs)	Resource Rate (\$/Hr)	Labor Savings Calculated (\$)	Labor Savings Scribed (\$)
Totals				\$ 0	\$ 0

+ Add

Non-Labor Savings Details

Resource Type

Select Resource Type

Activity Description

Labor Savings (Hrs)

Resource Hourly Rate

Select Resource Rate

Labor Savings Calculated (\$)

\$ 0

Labor Savings Scribed

0

Delete

Save

Figure 33. Adding data to the work reduction opportunity labor cost reduction worksheet page.

### Non-Labor Cost Reduction Worksheet Page

The non-labor cost reduction worksheet page provides a method to document the total estimated non-labor savings upon implementing the work reduction opportunity (see Figure 34). Similar to labor savings, there is a field to enter a basis for non-labor cost reductions followed by a table that includes non-labor item description, cost category, quantity, unit of measure, cost per unit, non-labor savings, and non-labor savings scribed. Data entered into the table is done by selecting the ‘+Add’ button to enable a modal window to appear (Figure 35). The user can then enter non-labor savings data and select ‘Save.’ The user can delete data by selecting the data from the table and then selecting the red ‘Delete’ button from the modal window.

Tools | Manage WRO Details

← Back

Capability:

TS|Test

Sub-Capability:

TS.01|TEST

Work Functions:

TS.01.A Test

Work Reduction Opportunity:

TS.01.A.01: Test

Manage WROs

Description
Technology Requirements
Success Criteria
Labor Cost Reduction Worksheet
Non-Labor Cost Reduction Worksheet
BCM Task Builder
Action Item Tracker

Basis for Non-Labor Cost Reduction:

Non-Labor Savings Opportunities

Brief Non-labor Item Description	Cost Category	Quantity	Unit of Measure	Cost per Unit (\$)	Non-Labor Savings (\$)	Non-Labor Savings (Scribed)
Totals					\$ 0	\$ 0

+ Add

Figure 34. Work reduction opportunity non-labor cost reduction worksheet page.

Tools | Manage WR

← Back

Capability:

TS|Test

Work Functions:

TS.01.A Test

Manage WROs

Description
Technology Requirements
Success Criteria
Labor Cost Reduction Worksheet
Non-Labor Cost Reduction Worksheet
BCM Task Builder
Action Item Tracker

Basis for Non-Labor Cost Reduction:

Non-Labor Savings Details

Brief Description

Cost Category

Select Cost Category

Quantity

Cost per unit

Unit of Measure

Non-Labor Savings

\$ 0

Non-Labor Savings (Scribed)

0

Delete

Save

Brief Non-labor Item Description	Cost Category	Quantity	Unit of Measure	Cost per Unit (\$)	Non-Labor Savings (\$)	Non-Labor Savings (Scribed)
Totals					\$ 0	\$ 0

+ Add

Figure 35. Adding data to the work reduction opportunity non-labor cost reduction worksheet page.

## BCM Task Builder Page

The BCM Task Builder (aka BCAM) page allows the user to input additional information of the work reduction opportunity that will be needed to develop a business case in the BCAM tool. There are several data fields that are fed into the BCAM from the table on this page (see Figure 36). The user can add or remove content in the similar workflow as the other pages previously described (see Figure 37). The data from the BCAM table, among various data inputs from the other work reduction opportunity pages, feed into the interface for the BCAM tool. More detail is provided in Section 2.7 on data integration.

Tools | Manage WRO Details

Back

Capability:

TS|Test

Sub-Capability:

TS.01|TEST

Work Functions:

TS.01.A Test

Work Reduction Opportunity:

TS.01.A.01: Test

Manage WROs

Description
Technology Requirements
Success Criteria
Labor Cost Reduction Worksheet
Non-Labor Cost Reduction Worksheet
BCM Task Builder
Action Item Tracker

BCM Tasks

Facilities	Task Id	Task Description	[Current State] Number of Items Completed	[Current State] How Long to Complete (Hrs/Unit)	[Future State] Number of Items Completed	[Future State] How Long to Complete (Hrs/Unit)	% Units Saved	% Tasks Impacted (Efficiency)	% Time Saved	Estimated Savings (People-Hrs)	Resource Rate (\$/Hr)	Estimated Savings (\$)	Comments/Qualitative Benefits
Add													

Figure 36. Work reduction opportunity BCAM page.

Tools | Manage WRO Details

Back

Capability:

TS|Test

Sub-Capability:

TS.01|TEST

Work Functions:

TS.01.A Test

Work Reduction Opportunity:

TS.01.A.01: Test

Manage WROs

Description
Technology Requirements
Success Criteria
Labor Cost Reduction Worksheet
Non-Labor Cost Reduction Worksheet
BCM Task Builder
Action Item Tracker

BCM Task Details

Facilities

Choose

Task Id

Task Description

Operator actions (stroke v

[Current] How many Items Completed?

0

[Current] How long to Complete?

0

[Future] How many Items Completed?

0

[Future] How long to Complete?

0

% of Units Saved

0

% of Tasks Impacted

0

Delete
Save

Figure 37. Adding data to the work reduction opportunity BCAM page.

## Action Item Tracker Page

The action item tracker page allows for the tracking of action items associated with implementing the work reduction opportunity. Action items are managed from a table and allow a user to enter a description of the action item, an assignment to staff, a due date, a required decision, issues/ concerns, an action item status, and ancillary comments (see Figure 38 and Figure 39).

Tools | Manage WRO Details

Back

Capability:
TS | Test

Sub-Capability:
TS.01 | TEST

Work Functions:
TS.01.A Test

Work Reduction Opportunity:
TS.01.A.01: Test

Manage WROs

Description
Technology Requirements
Success Criteria
Labor Cost Reduction Worksheet
Non-Labor Cost Reduction Worksheet
BCM Task Builder
Action Item Tracker

Action Items

Action No.	Wro Id	Action Item	Assignment	Due Date	Decisions Required	Issues/Concerns	Status	Other Comments
<div>+ Add</div>								

Figure 38. Work reduction opportunity action item tracker page.

Tools | Manage

Capability:
TS | Test

Work Functions:
TS.01.A Test

Description
Technology Requirements
Success Cr

Action No.	Wro Id	Action Item
<div>+ Add</div>		

WRO Id
50

Action Item Description

Assigned To

Due Date

Decisions Required

Issues/ Concerns

Status
Select Status

Other Comments

Delete
Save

Back

Manage WROs

sheet
BCM Task Builder
Action Item Tracker

ncerns
Status ||
Other Comments ||

Figure 39. Adding data to the work reduction opportunity action item tracker page.

#### 2.5.4.2 Managing work reduction opportunities: adding a new work reduction opportunity

Work reduction opportunities can be managed in a similar way to how capabilities, sub-capabilities, and work functions are managed. The user can add a new entry by selecting ‘Manage WROs’ (see Figure 28). A modal window, with a table of work reduction opportunities, is then provided to the user. The user can then select the ‘+Add’ button from the modal window to create a new entry. A second modal window will appear to allow the user to enter metadata about the new work reduction opportunity. The user will select ‘Save’ to submit modifications for the new work reduction opportunity.

### **2.5.4.3    *Managing work reduction opportunities: modifying or deleting an existing work reduction opportunity***

Modifying or deleting an existing work reduction opportunity follows the same convention as modifying or deleting existing capabilities, sub-capabilities, and work functions. The user first selects ‘Manage WROs’ (see Figure 28) where a modal window will appear. The modal window will provide a table of existing work reduction opportunities. The user can modify a given work reduction opportunity by selecting it from the table and changing the metadata directly from a second modal window. The user can also delete the work reduction opportunity by selecting the red ‘Delete’ button.

## **2.6    Link to the Innovation Portal**

Enabling technology can be used to support cost reductions at the work reduction opportunity level. As shown previously in Figure 30, the user can add technologies to the work reduction opportunity’s requirements from the technology requirements page. There may be cases where the user would like to understand:

1. The benefits of a specific technology to support plantwide transformation
2. What other related technologies are available to support this work reduction opportunity
3. What vendors are available for a specific technology
4. What R&D has been done to assess its level of maturity.

To support answering these questions, each dropdown box that provides a list of enabling technologies has a link to the Innovation Portal. Specifically, upon selecting a link for a given technology, the user will be taken to a detailed page on the Innovation Portal to learn more about that technology. Upon selecting the link (refer back to Figure 30), a new browser tab will open the specific Innovation Portal so that the user can still work through the ICAP. Additionally, the Innovation Portal can be accessed from the home page of the ICAP. When the user selects the link from the ICAP home page (refer back to Figure 16), the user will be taken to the Innovation Portal home page to begin a new query. A detailed description of the navigation in the Innovation Portal is described in Section 3.

## 2.7 Integration with the Business Case Analysis Model (BCAM)

Integration between the ICAP and BCAM takes place at the work reduction opportunity level. Specifically, a subset of variables for a work reduction opportunity found across the key pages are used to develop a business case in the BCAM. For the user, data entered in the ICAP can be entered directly into the BCAM when setting up a business case in the BCAM tool.

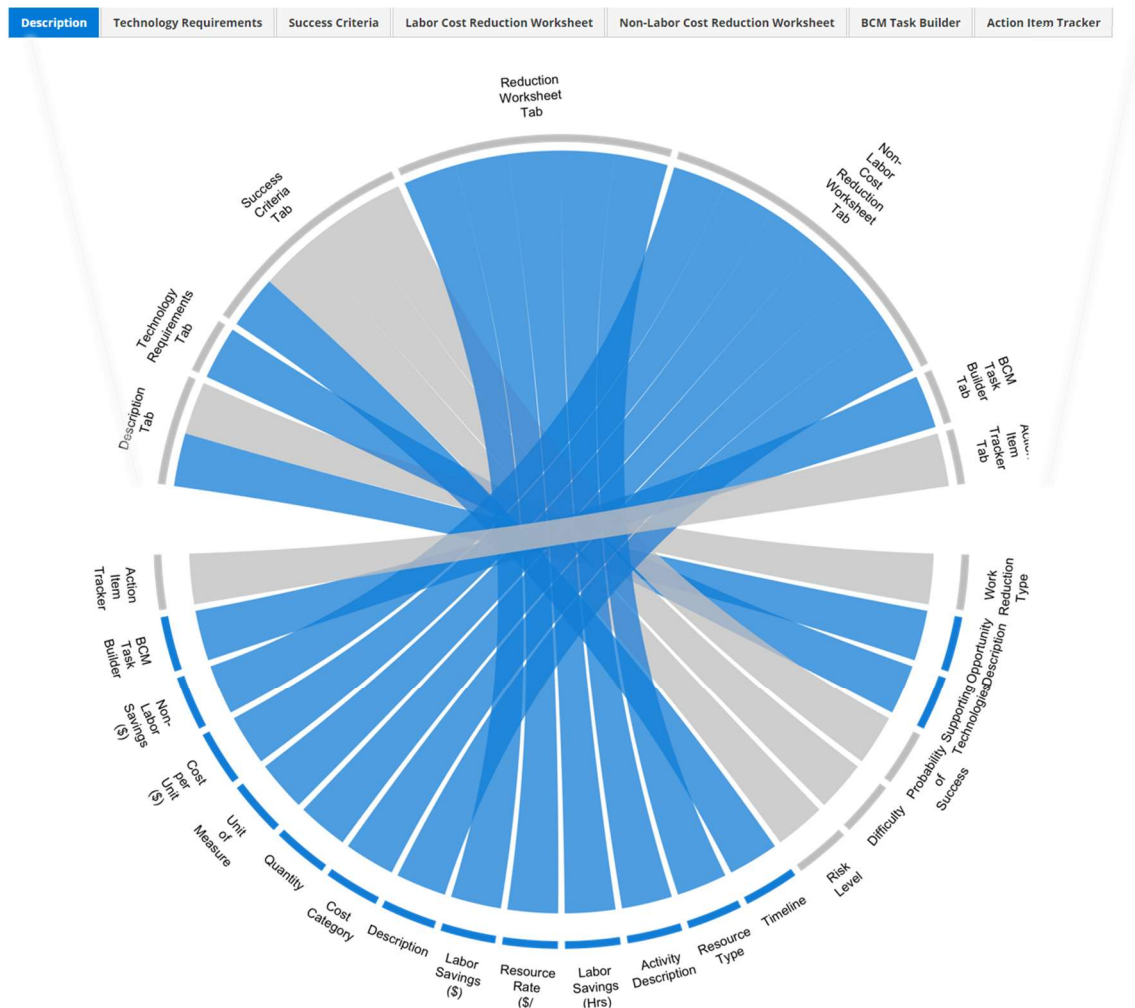


Figure 40. Work reduction opportunity data mapping into the BCAM for business case development.

The subset of data used in the BCAM from the ICAP work reduction opportunity pages are illustrated in the chord diagram (see Figure 40). Here, the chord diagram maps the variables used in the BCAM across the seven work reduction opportunity pages of the ICAP. The data presented on the bottom section of the chord diagram represents each input field from the ICAP work reduction opportunity page, and the top section shows the tabbed page where the user can find these fields. The blue links show fields for a given tabbed page that are used in the BCAM. A key observation is that a large subset of ICAP data for each work reduction opportunity can be used to support developing a business case in the BCAM; most of the data from ICAP needed in the BCAM comes from the ‘Labor Cost Reduction’ and ‘Non-Labor Cost Reduction’ worksheets, respectively. This integration should reduce setup time and enhance the user experience when using the BCAM.



### 3. INNOVATION PORTAL

#### 3.1 Purpose of the Innovation Portal

The Innovation Portal is a web-based system that provides ready access to current innovative technologies and processes along with INL reports and pilot project studies. The Innovation Portal can be accessed as a stand-alone system or can be used within the ICAP to identify solutions that will enable work reduction opportunities.

The origin of the Innovation Portal can be traced to the roadmap for nuclear innovation, which relates base (commercial off-the-shelf) technologies to advanced capabilities and integrated technologies (see Figure 41). This roadmap provides a holistic approach to support identifying and selecting reliable technology that addresses the business need of reducing O&M costs (Kovesdi et al., 2019). As base technologies support the realization of advanced capabilities and integrated technologies, each advanced capability and integrated technology further supports specific functional areas of the plant. The relation between these three layers are, in many cases, many-to-one. The Innovation Portal was designed to help identify these relations to support a strategic selection of technology/process for a specific work reduction opportunity that can be realized across the plant.

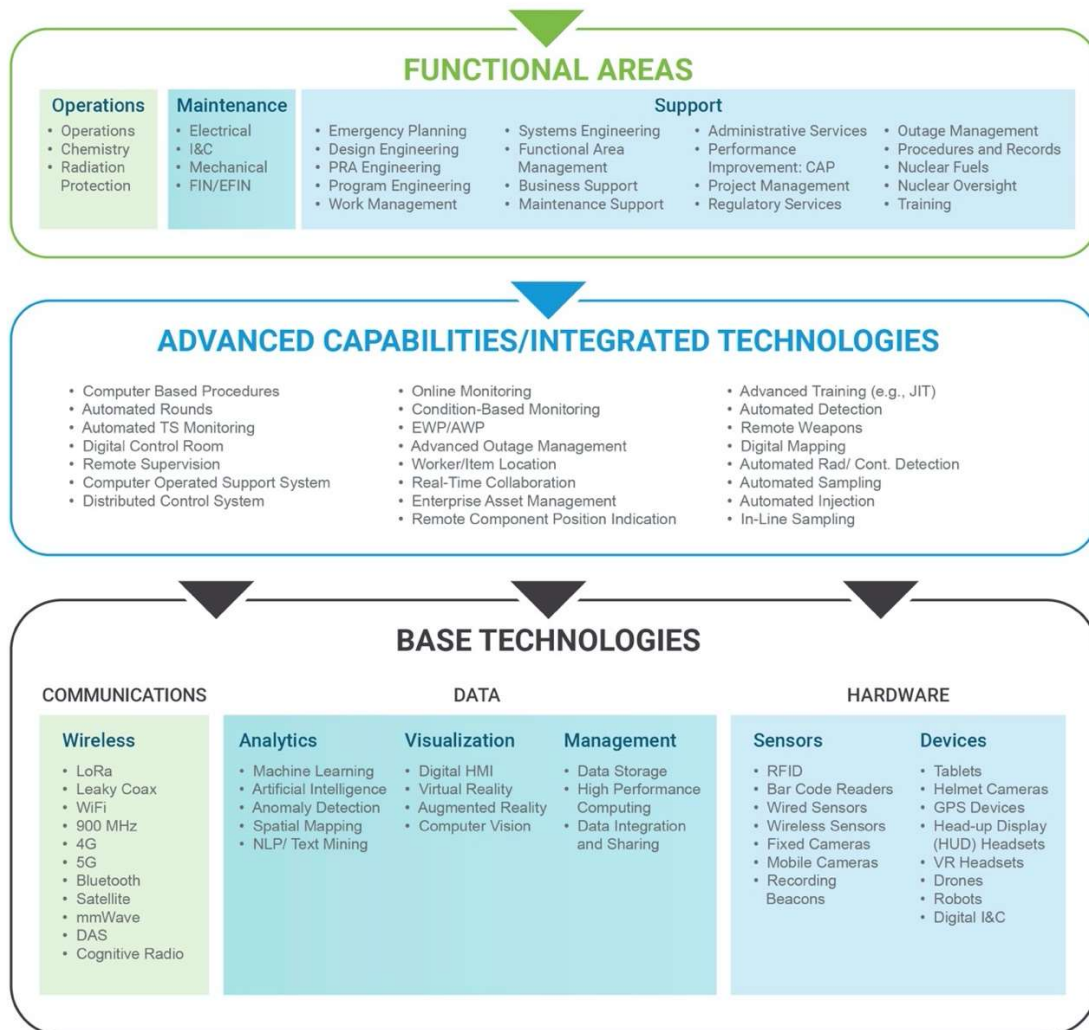


Figure 41. Roadmap for nuclear innovation (adopted from INL/EXT-19-55529).



## 3.2 Innovation Portal Features

The nuclear innovation roadmap served as a basis for developing the Innovation Portal navigation architecture. Shown in Figure 42, there are three layers: functional areas, advanced capabilities, and integrated technologies, and enabling technologies. These layers map to the roadmap shown previously in Figure 41. Each of the items in these layers are clickable links that provide detailed information of these areas when clicking.

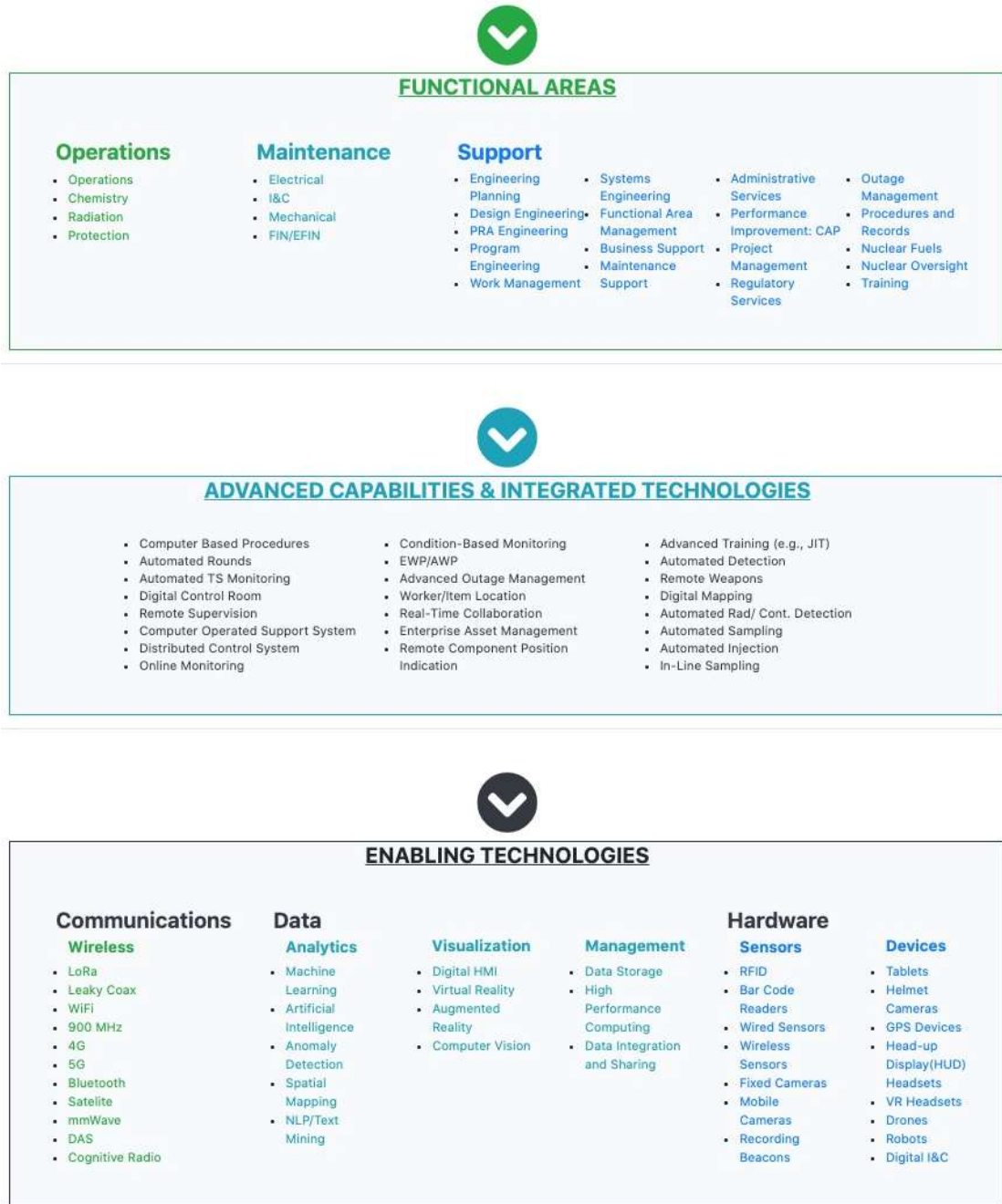


Figure 42. Home page for the Innovation Portal.

## 3.3 Using the Innovation Portal

The following section describes the ways in which a user can find detailed information from the Innovation Portal. These ways can be characterized by searching through the roadmap interface (see Figure 42), searching through the query, and searching from the ICAP.

### 3.3.1 Searching by the Roadmap

If the user is entering the Innovation Portal from the home page (the roadmap), detailed information can be found by selecting any given link from the three hierarchical layers. Upon selecting a link, the user will be taken to a new page with this detailed information.

Figure 43 shows an example page for an advanced capability (middle layer). In this example, the user can find a description of the capability and its benefits as text information. The user can drill in further for more information on available products, related functional areas and enabling technologies, applicable standards and guidelines, demonstrations, and deployments by selecting the links available from this detailed page. For example, when selecting a product, the user will be taken to the manufacturer's webpage. Links to standards and guidelines are also live from the detailed page, and there are links to LWRS reports that have been done specifically on the development of a demonstration. The user can also navigate the roadmap hierarchy from the related functional areas and enabling technologies links. Finally, if the user needs more information that is not directly available, there is a point of contact link to an LWRS principal investigator.

The screenshot shows a web page for the LWRS (Light Water Reactor Sustainability) Innovation Portal. The header includes the LWRS logo and the title 'Advanced Capabilities | Computer Based Procedures'. A 'Back' button is in the top left. The main content area is titled 'Description:' and contains a paragraph about work instructions. Below this is a 'Requirements/Benefits:' section with a grid of bulleted items. At the bottom, there are three columns: 'Available Products:', 'Related Enabling Technologies:', and 'Demonstrated Resources:'. There is also a 'Related Functional Areas:' section and a 'Point of Contact:' section.

**← Back**

**Advanced Capabilities | Computer Based Procedures**

**Description:**

Work instructions will be consistent across all organizations and will be streamlined to provide only task-relevant and condition-relevant instructions to the user. Work instructions will be presented on a mobile device and users will have real-time access to supporting information, just-in-time-training, and communication tools. Conditions encountered in the field will be documented with rich media and information will be updated in real-time to all relevant systems. Control room operators and decision makers will have real-time awareness of conditions in the field and better understanding of plant status.

**Requirements/Benefits:**

- **Remote monitoring of status (plant, equipment, procedure)**
  - Less time waiting
  - More precise scheduling
- **Automatic verification (correct component, worker qualifications, plant conditions)**
  - Fewer corrective actions
  - More efficient procedure execution
- **Real-time communication**
  - Improved communication
  - Less time waiting
  - More efficient procedure execution
- **Automatic updating (plant, equipment, record keeping)**
  - Better tracking of plant status
  - Fewer procedural conflicts
  - More efficient record keeping for compliance
- **Automatic tracking of administrative tasks (placekeeping, signoffs)**
  - More robust record keeping
  - More efficient procedure execution
- **Automatic processing of field data (calculations, checking tech specs, limits, thresholds)**
  - Fewer human errors
  - Fewer corrective actions
  - More robust record keeping
- **Dynamic/Context-sensitive instructions**
  - Fewer human errors
  - Reduced time managing procedures
- **Capture of media in the field**
  - Better transfer of knowledge
  - Improved decision making
  - Faster resolution of emerging issues
  - Fewer human errors
- **Appealing user interface**
  - Recruitment and retention of skilled workforce

**Available Products:**

- NextAxiom Electronic Work Management
- DataGlance
- ATR Smart Procedure
- LeanPower
- Tecnomat

**Related Functional Areas:**

- Operations
- Procedures and Records
- Maintenance Support
- Work Management

**Related Enabling Technologies:**

- 4G
- WiFi
- Tablets
- Bar Code Readers
- RFID
- Wireless Sensors
- Mobile Cameras
- Data Storage
- Data Integration and Sharing

**Applicable Standards, Guidance, and Reports:**

**Demonstrated Resources:**

- LWRS: INL-PVGS Collaboration

**Deployment Resources:**

- IAEA: Dynamic computer based procedures system for the AP1000 plant

**Point of Contact:**

Katya Le Blanc

Figure 43. Detailed page in the Innovation Portal (computer based procedures).

Figure 44 shows another example of a detailed page for an enabling technology. Similarly, there are links that will take the user to additional information on vendors, applicable guidelines and standards, LWRS reports, utilities who have implemented the technology, and any associated media. The user can also navigate from this layer of the roadmap to related capabilities that utilize the enabling technology.

## Enabling Technologies | Digital HMI

← Back

**Description:**

The human-machine interface (HMI), also referred to as human-system interface (HSI), is part of the system through which plant personnel (e.g., operators) interact to perform their functions and tasks. Machine/system refers to a nuclear power plant.

**Applicable Advanced Capabilities/Integrated Technologies:**

- Digital Control Room
- Computer Operated Support System
- Distributed Control System
- Remote Supervision

**Available Vendors:**

- Westinghouse/Ovation
- General Electric (GE)
- Honeywell Experion
- Mitsubishi
- Curtiss-Wright

**Utilities who have implemented or will implement the technology:**

- Palo Verde
- Southern
- Duke
- Dominion

**Applicable Guidelines and Standards for Technology Implementation:**

Regulatory Standards

- 10 CFR 50.59

NRC Guidance

- NUREG-0700
- NUREG-0711
- NUREG-0737
- NUREG-0800

ISO Guidance

- ISO 9241

EPRI Guidance

- 3002004310
- 3002011816

**Implementation Suggestions:**

To ensure successful implementation of digital HMIs, it is highly suggested to fully involve human factors engineering into the development of the design and functionality of digital HMIs that control various plant functions. Additional reading:

- INL/EXT-18-51107
- INL/EXT-18-44798
- INL/EXT-18-51212
- INL/EXT-18-51365

**Associated Media:**

Launch Media

Figure 44. Detailed page in the Innovation Portal (Digital Human-Machine Interface).

3.3.2 Searching through Query

The user will also be able to search the Innovation Portal by querying via a search bar for specific key words (see Figure 45). The Innovation Portal enables the user to search by manufacturer (or vendor) name or report name. Searching by manufacturer (or vendor) name will show the user-related functional areas, advanced capabilities, and enabling technologies associated with the search term. Searching by report will show a list of related reports with the key search term.

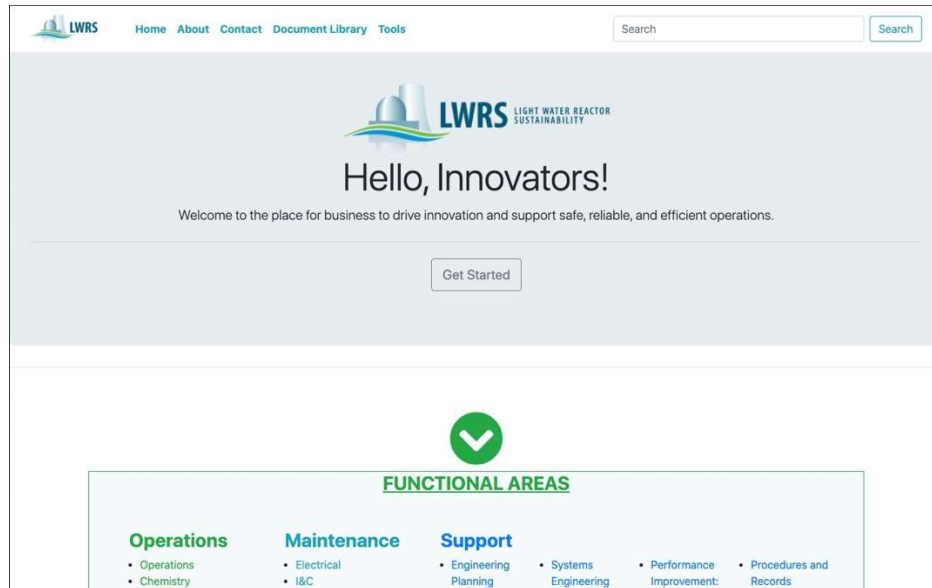


Figure 45. Screenshot of Innovation Portal showing the top tool pane with links to ICAP and search bar functionality.

### 3.3.3 Searching from the ICAP

As described in Section 2.6, the user can work from the ICAP and navigate directly to the IP from the technology requirements page within a given work reduction opportunity. This use case is likely to occur if the user is looking for technologies that will support a specific work reduction opportunity but would like to learn more about it. In this case, the user has the option to select a link that will navigate directly to the detailed page of interest.

## 3.4 Data Management for the Innovation Portal

The links from the Innovation Portal home page (refer back to Figure 42) and detailed information presented for the functional areas, capabilities, and enabling technology pages (e.g., refer back to Figure 43 and Figure 44) are displayed and read from a structured query language (SQL) relational database using an application programming interface (API) developed using the C# general purpose programming language. This framework allows for content to be configured and updated dynamically by those who have administrative access. In the initial rollout of the Innovation Portal, administrative access will be granted through review by the LWRS Program, as part of provided quality assurance to the information shared from the Innovation Portal. Similar to ICAP, the Innovation Portal will allow a user with administrative access to enter information using similar interface conventions shown from the ICAP.

## 3.5 Links to Vendor Supplied Information

Vendors will have the capability of providing links to associated capabilities and enabling technology. The links will take the user directly to the vendor's webpage, shown in a new browser tab. Links can be added by those with administrative access. The purpose of these links is to facilitate the knowledge sharing of available commercial off-the-shelf technologies that can be implemented strategically such that it aligns with the ION business framework.

## 3.6 Link to the Integrated Operations Capability Analysis Platform

As shown in Figure 45, the 'Tools' link in the top pane of the Innovation Portal links the user to the ICAP. When selected, a new browser tab will open the home page of the ICAP (refer back to Figure 10).

## 4. BUSINESS CASE ANALYSIS MODEL

EPRI has developed the BCAM, a comprehensive business case application, based on prior LWRS program work that developed and demonstrated the business case methodology workbook (BCMW). The BCAM is a complex Microsoft Excel workbook that compiles the detailed work activity savings from the ION innovation framework and aggregates the benefits into an overall business case format. This business case provides a calculation of harvestable savings, such as reduced full-time equivalent, and provides the present worth of the benefits.

The ICAP is being interfaced to the BCAM, so labor and non-labor data can be seamlessly transferred to produce the needed investment business cases (refer back to Figure 40 for data mapping). Scott Madden and Associates are currently developing an interface that will provide the needed functionality and data integrity. The ICAP will enable the transfer of data entered for a given work reduction opportunity into a format that is readable by Microsoft Excel to support BCAM integration. Figure 46 highlights the primary interface between ICAP select data to the BCAM.

Description Technology Requirements Success Criteria Labor Cost Reduction Worksheet Non-Labor Cost Reduction Worksh									
Task Description ↑↓	Impacted? ↑↓	[Current State] Number of Items Completed ↑↓	[Current State] How Long to Complete (Hrs/Unit) ↑↓	[Future State] Number of Items Completed ↑↓	[Future State] How Long to Complete (Hrs/Unit) ↑↓	% Units Saved ↑↓	% Tasks Impacted (Efficiency) ↑↓	% Time Saved ↑↓	Estimat Savings (People Hrs) ↑
1	true	10	100	6	600	5	25	5	24
+ Add									

bcmtasks\_export\_...xlsx

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Figure 46. ICAP export capabilities of select parameters used in the BCAM.

## 5. SUMMARY

In order to support the implementation of Integrated Operations for Nuclear (ION) across the nuclear industry, the LWRS program has developed the Integrated Operations Capability Analysis Platform (ICAP) and the Innovation Portal. These tools will allow utility innovators to evaluate their current business processes, determine how these processes can be changed, modified or in some cases eliminated and select the right technology to enable this transformation. In addition, the ICAP has been seamlessly integrated with the EPRI Business Case Analysis Model (BCAM) to allow further detailed analysis of work functions and generation of positive business cases. These tools, while useful independently, will provide the greatest value to nuclear power transformation efforts when applied synergistically. A summary of these tools is provided below:

- *ICAP*. The Integrated Operations Capability Analysis Platform (ICAP) is a software application that contains the data, structure, and results using the ION Capability Analysis framework to identify work reduction opportunities and eliminate duplication of work activities. Live links to the Innovation Portal and the BCAM is provided within the ICAP program.
- *Innovation Portal*. The Innovation Portal is a web-based software program that serves as a resource catalogue of advanced technologies, processes, methods, and ideas backed up by LWRS Program research and development. The Innovation Portal will also serve as a clearinghouse for technologies and processes already used by other utilities engaging in transformative efforts.
- *BCAM*. The Business Case Analysis Model (BCAM) is an EPRI product originally developed by the LWRS Program. It is an Excel-based tool that allows users to perform work function analysis and develop business cases for process and technology innovation. BCAM is available for stand-alone use or it can be accessed through the ICAP.

It is hoped that using these tools to implement Integrated Operations for Nuclear will allow nuclear utilities to transform their business operations, reduce operations and maintenance costs and achieve and maintain a positive economic presence in the future energy market.

## 6. REFERENCES

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- 2) Reegard, K., A. Drøivoldsmo, G. Rindahl, and A. Fernandes. 2014. “The Capability Approach to Integrated Operations Handbook.” IFE/HR/F-2014/1604, Center for Integrated Operations in the Petroleum Industry.
- 3) Thomas, K., J. Remer, C. Primer, D. Bosnic, H. Butterworth, C. Edwards, G. Foote, A. Drøivoldsmo, G. Rindahl, R. McDonald, S. Lawrie, and E. Baker. 2020. “Analysis and Planning Framework for Nuclear Power Plant Transformation.” INL/EXT-20-59537, Idaho National Laboratory.