

## **RTI International Annual Report**

*State Fiscal Year 2014–2015 Report of Program Activities, Objectives and Accomplishments;  
and Itemized Expenditures and Fund Sources*

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## REPORT OVERVIEW

- For the 2014–2015 fiscal year (FY), RTI received a nonrecurring State appropriation of \$500,000 to match U.S. Department of Energy research and development funds.
- RTI utilized the full \$500,000 of the State's investment in this program, allowing RTI to attract \$2,784,455 in federal energy research funds, along with additional private sector investment.
- As a result, for every \$1 in State FY 2014-2015 funds utilized by RTI, North Carolina attracted \$5.57 in corresponding federal investment to support its economy.

As provided in Session Law 2013-360, Section 15.25, RTI International (RTI) is pleased to submit this report of State fiscal year program activities, objectives, and accomplishments and prior State fiscal year itemized expenditures and fund sources.

## **ABOUT RTI**

In 1958, the idea of Research Triangle Park (RTP) was born with the guidance and support of government, education, and business in North Carolina. Located in the rolling hills of the Piedmont, the Research Triangle is defined by outstanding universities in the Triangle's three cities: North Carolina State University in Raleigh, Duke University and North Carolina Central University in Durham, and the University of North Carolina at Chapel Hill. RTI was the original anchor tenant in RTP.

As RTP expanded and prospered after its inception, so did RTI. Growing from a handful of scientists in central North Carolina in 1959 to a staff of more than 3,700 in more than 75 countries today, RTI is now one of the world's leading independent, nonprofit research and development organizations.

Our activities both mirror and support national priorities and policies as well as diverse commercial, industrial, and academic endeavors. For instance, as public and government interest in environmental protection grew in the 1960s, so did related programs at RTI, building on our expertise in statistical, physical, and life sciences.

As our mission affirms, we are dedicated to improving the human condition by turning knowledge into practice through cutting-edge study and analysis in health and pharmaceuticals, education and training, surveys and statistics, advanced technology, international development, economic and social policy, energy and the environment, and laboratory and chemistry services.

We are proud of our scientific stature and our reputation for innovation. By continuing to conduct impartial, reliable, multidisciplinary research and by helping to develop and broker new technologies for our clients, we seek to be the world's preferred resource for turning knowledge into practice.

## **ENERGY RESEARCH AT RTI**

RTI's innovative energy research is geared toward solving national and global concerns by developing efficient, economic, and sustainable energy solutions. Our scientists and engineers address challenges across the power, chemical, petroleum, gas processing, and

transportation industries to produce novel technologies from ideation to pilot scale to commercialized systems.

Our state-of-the-art facilities and laboratories are equipped to provide high-quality R&D for process technology licensors, gas processing companies, oil refiners, chemical manufacturers, clean-fuels developers, catalyst manufacturers, and other commercial clients, as well as for the U.S. Department of Energy (DOE), Department of Defense, and other government agencies. Our capabilities range from lab- and bench-scale experiments to pilot plants and large-scale pre-commercial demonstration.

Our energy R&D programs are focused into seven primary areas, all of which are important for the production and utilization of clean, secure, and safe domestic energy in our state and in our nation:

- Natural gas (extraction, clean-up, and conversion)
- Biomass conversion into fuels and chemicals
- Syngas clean-up and conversion (such as from coal, petroleum residues, biomass, and wastes)
- Carbon capture and utilization
- Industrial water treatment and recycle/reuse
- Solid-state lighting
- Emerging sustainable energy (such as solar energy transfer and storage)

RTI develops advanced technologies for energy applications from concept to large scale demonstration, with a focus on applied research. We partner with the largest energy and chemical companies in the world and leverage our state support to enter new R&D areas, build new technology platforms, and build a technology base for future commercialization of new energy technologies. RTI is unique in North Carolina, with a world class reputation in the energy sector.

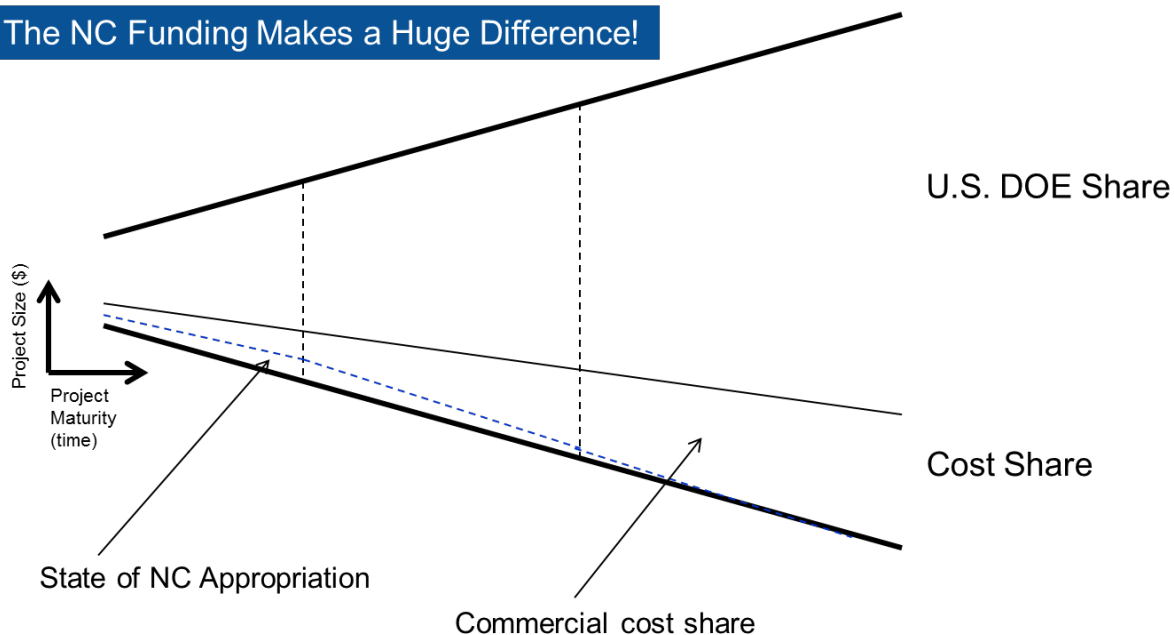
## **IMPORTANCE AND VALUE OF THE GRANTS APPROPRIATED TO RTI IN THE STATE BUDGET**

### **North Carolina State Funding as an Investment in Energy Technology Development**

RTI develops advanced energy technologies mainly under the funding from the U.S. DOE. These federal research awards require a cost share or match from non-federal sources, typically 5% or 20%, depending on the funding program. RTI's first priority is to develop partnerships with industry that can attract this cost share match from the private sector, and RTI has a successful track record for building these industry alliances. However, the development of new technologies often makes it difficult to attract such cost share

requirements until the technologies are sufficiently proven to attract private sector investment. State matching funds allow RTI to cover this early cost share gap and to demonstrate the viability of new technologies – and then attract private sector investment as they mature. As projects are further advanced, industry often picks up the full funding load for U.S. DOE cost share requirements.

**The NC Funding Makes a Huge Difference!**

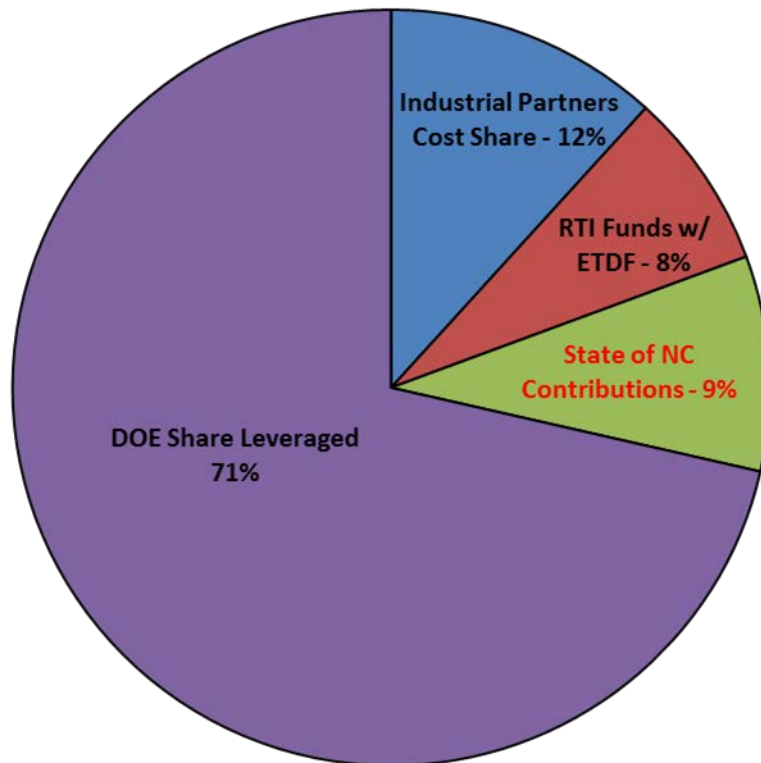


The State Budget approved by the legislature for Fiscal Year (FY) 2014–2015 included a \$500,000 grant to assist RTI in winning federal energy research grants that require cost share or match. The goal of this grant is to help RTI advance energy research in North Carolina and create jobs in this important and growing part of the state’s economy. The key points of how RTI utilizes the grant and benefits to the State can be summarized as follows:

- North Carolina state funding helps RTI to initiate development of at least three to five additional energy technology concepts per year. This year, a total of five development projects have benefited from the state funding.
- This fiscal year RTI utilized the full \$500,000 of the State's funding to attract \$2,784,455 in federal energy research funds, along with additional private sector investment. As a result, for every \$1 in State FY 2013-2014 funds utilized by RTI, North Carolina attracted \$5.57 in federal investment to support its economy.
- Together with U.S. DOE funding and in partnerships with leading industrial companies RTI builds a pipeline of innovative technologies addressing the energy challenges of our state and of our nation.

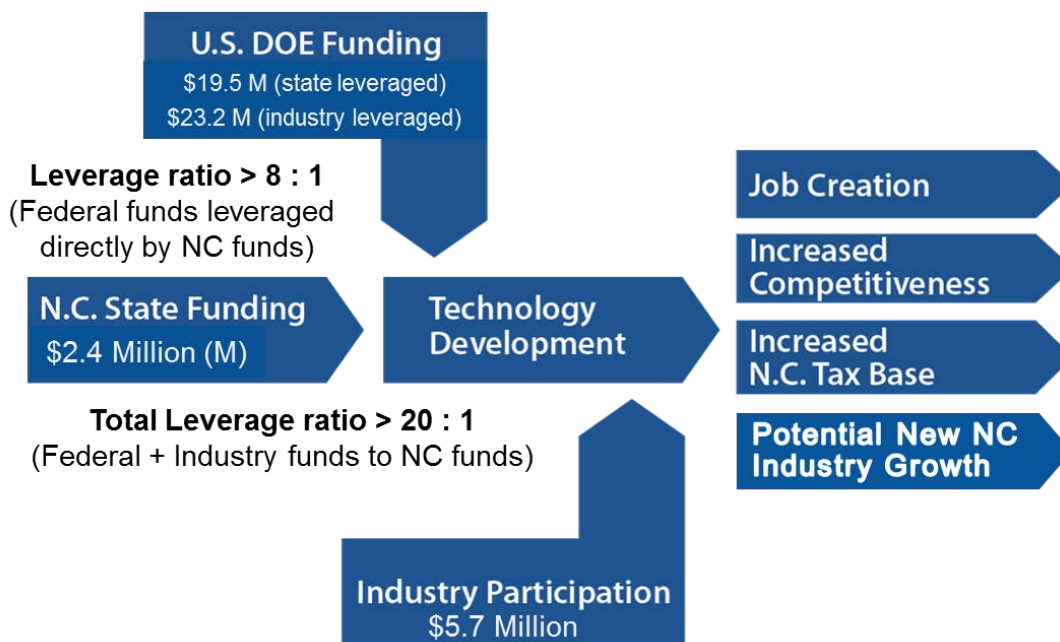


- Since initiation of the state funding program in 2010, the State of North Carolina has invested ~\$500,000 annually to help RTI attract federal and private funding for energy technology development in NC. This total State funding to date has helped attract approximately \$25 million in total new technology investment to NC's economy, including investments made by the federal government, industry, and RTI.



#### **FY2011-FY2015 RTI Energy Funding Breakdown**

- Total state funding during the past five years has allowed RTI to attract \$19.5 million in federal research grants to the state (based on only the federal investment cost-shared directly by these state funds). This amounts to over \$8 in federal funds for every \$1 in state funds, using the most conservative method for this calculation.
- Private industry has invested an additional \$5.7 million in cash and in-kind services in the RTI energy projects directly supported with state funding, and these industry investments have enabled the leveraging of additional federal investment.
- If one considers this additional private sector investment in RTI energy projects and the resulting combined federal investment that is leveraged, North Carolina's return on investment is over \$20 for every \$1 in state funding.



#### LEVERAGING OF FY2011-FY2015 RTI STATE FUNDING

- Investment in new technologies leads to increased economic competitiveness. It creates high-paying jobs, typically attracting talent from outside of the state and resulting in significant economic input to the state of North Carolina. Since North Carolina began investing in RTI’s energy research in FY 2010-2011, RTI has created or supported approximately 50 high-tech jobs associated with this research.
- In addition to jobs, RTI estimates that for every \$1 in state funds invested in RTI energy research, North Carolina has received approximately \$2.80 back in state and local taxes.
- State-supported research at RTI regarding solid-state (LED) lighting has also benefited the N.C. State Construction Office, the Department of Environmental and Natural Resources, the Department of Public Health, UNC-Chapel Hill, and N.C. State University and other agencies.

## STATE FISCAL YEAR 2014–2015 PROGRAM ACTIVITIES, OBJECTIVES, AND ACCOMPLISHMENTS

In this 2014-2015 state fiscal year, utilizing the full \$500,000 of the State's funding has greatly assisted in further building RTI's technology development pipeline, attracting \$2,784,455 in federal research dollars (5.57:1 federal leverage ratio) along with approximately \$600,000 in industry and other funding to the state, successfully retaining and creating jobs in the state of North Carolina. The table below shows the leveraging of Federal funds through State funding.

### Leveraging of Federal Funds through State Funding

| Federal Dollars Leveraged Through Use of State Funding  |                       |                                   |
|---|-----------------------|-----------------------------------|
| Project/Proposal  | NC Funds<br>Used (\$) | Federal Dollars<br>Leveraged (\$) |
| <b>Carbon, Hydrogen, and Separation Efficiencies in Bio-oil Conversion Pathways</b>   | 213,998               | 855,992                           |
| <b>SSL Luminaries Add-On</b>  | 123,705               | 494,820                           |
| <b>Low CO<sub>2</sub> Coal-to-Liquids</b>   | 110,000               | 440,000                           |
| <b>Fouling-Resistant Membranes for Treating Concentrated Brines for Reuse in Advanced Energy Systems</b>                          | 39,868                | 757,492                           |
| <b>Internal Combustion Engine Reformer/Converter for Gas-to-Liquids Conversion Collaboration with MIT and Columbia University</b> | 12,429                | 236,151                           |
| <b>Total</b>  | <b>500,000</b>        | <b>2,784,455</b>                  |

Specific projects benefiting from State of NC funds and the goals of and accomplishments within those projects are highlighted below:

- Carbon, Hydrogen, and Separation Efficiencies in Bio-oil Conversion Pathways.**  
RTI used \$213,998 of its FY2014-2015 state funding to secure \$855,992 of leveraged funding from the U.S. DOE to advance RTI's process technology for the cost competitive production of transportation fuels from biomass. RTI has been developing a catalytic biomass pyrolysis process over the past several years and is now operating a one ton per day pilot plant at its Energy Technology Development Facility in Research Triangle Park to convert biomass into a "biocrude" that can be upgraded to transportation fuel using technology commonly used in petroleum refining. Effective hydrogen utilization is

a major factor in increasing the cost competitiveness of bio-based fuels. Under this new project, RTI has been developing a novel catalyst technology that will reduce the overall hydrogen demand and a process to improve the carbon efficiency by recovering carbon that leaves the process in a waste water stream and returning it to beneficial use in the process. Veolia Water, a global leader in water treatment technologies with major offices in Cary, NC, has been helping RTI to optimize the overall process by recovering valuable carbon from process wastewater.

2. **Solid-State Lighting Luminaries Add-On.** RTI used \$123,705 of its FY2014-2015 state funding to secure \$494,820 of leveraged funding from the U.S. DOE for extensive testing and model development to demonstrate that SSL light sources are extremely durable and can be expected to operate much longer than conventional light sources under normal operational conditions. RTI evaluated SSL devices under high stress conditions designed to simulate years of field use. RTI has identified the weak points in LED lighting systems and compared them to conventional light technologies. RTI's work in this area also provided RTI scientists and engineers with access to leading lighting manufacturers and the latest lighting research and product developments from around the world. To spread the benefits of this work, RTI recently teamed with lighting designers and engineers from various North Carolina state agencies to examine the benefits and limitations of SSL technologies. As part of this partnership, RTI has hosted five solid-state lighting users workshops aimed at state-owned buildings. The workshops were attended by representatives from the State Construction Office, Department of Environmental and Natural Resources, Department of Public Health, UNC-Chapel Hill, and N.C. State University. RTI anticipates that these meetings will provide significant benefits to the state by improving lighting systems specifications, promoting the greater use of energy-saving SSL technologies, providing the state's lighting designers and engineers with access to cutting edge SSL research at RTI and elsewhere, and improving the overall reliability of lighting systems in state buildings. As an outcome from these workshops, RTI is working with the participants to develop guidance documents for new construction and lighting retrofits that will be shared with lighting engineers and specifiers throughout state offices. The guidelines will also be presented in a joint paper with the NC Department of Environment and Natural Resources (DENR) at the State Energy Conference in 2016. These workshops will also benefit RTI and its efforts to build reliability models for SSL luminaires by providing real-world feedback on observed failure modes for SSL devices and information on expected performance levels and investment returns for SSL systems.
3. **Low CO<sub>2</sub> Coal-to-Liquids.** RTI used \$110,000 of its FY2014-2015 state funding to secure \$440,000 of leveraged funding from the U.S. DOE to help develop a breakthrough hybrid coal-to-liquid process technology to produce jet fuel. The project was led by RTI, in partnership with Aerojet Rocketdyne and the Gas Technology

Institute. RTI and its partners have addressed key issues that hinder the use of coal to produce jet fuel, including high capital costs associated with the conversion process. Within the terms of the multi-year, multi-phase overall cooperative agreement funded by the DOE, RTI will work to develop a hybrid process technology that combines coal and natural gas to generate a syngas that is subsequently converted to jet fuel. RTI aims to rapidly progress this hybrid technology for potential commercial deployment in the next five to ten years. The process integrates several advanced emerging technologies, including RTI's warm syngas cleanup and novel syngas-to-liquids technologies, and is anticipated to cost 25-30% less than conventional technologies.

4. **Fouling-Resistant Membranes for Treating Concentrated Brines for Reuse in Advanced Energy Systems.** RTI used \$39,868 of its FY2014-2015 state funding to secure \$757,492 of leveraged funding from the U.S. DOE for this project. The complex range and high concentrations of salts, minerals, and metals that make up the total dissolved solids (TDS) found in concentrated brines generated throughout the fossil fuel lifecycle severely limit current treatment and disposal options. The high TDS levels in concentrated brines (often 8 times higher than that of seawater) make current approaches to water treatment untenable. In this project, funded by the DOE, RTI has been developing a low-cost, novel water treatment process using electrically conductive membrane distillation (ECMD) for the reuse of concentrated brines. This project's goal is to develop a new class of advanced ECMD membranes that will mitigate the fouling issues that often occur during water treatment, paving the way for expanded water reuse and discharge options beyond what is currently feasible. Anticipated benefits/outcomes of the advanced technology will include at least 50% reuse of treated water, 35% to 90+% reduction in water treatment cost, and improvement in membrane fouling relative to existing membranes. RTI is collaborating with Veolia Water, a global leader in wastewater services with major offices in Cary, NC.
5. **Internal Combustion Engine Reformer/Converter for Gas-to-liquids Conversion.** RTI used \$12,429 of its FY2014-2015 state funding to secure \$236,151 of leveraged funding from the U.S. DOE to design a facility to demonstrate a novel approach that uses a modified internal combustion engine and gas-to-liquid technology developed by RTI to enable an economic, small-footprint modular process design for conversion of natural gas to liquid fuels and electric power. Such a small-footprint design would enable production of high-value chemicals and fuels directly on-site from stranded or associated natural gas (that is currently vented or burned at oil well sites or landfill sites) or on-site from shale gas wells. This project is being conducted in cooperation with MIT and Columbia University, but the design and ultimate testing are to be performed at RTI here in NC. The demonstration facility has now been designed and the project is ready to proceed to the equipment procurement, installation, and testing phase.

## STATE FISCAL YEAR 2014-2015 ITEMIZED EXPENDITURES AND FUND SOURCES

The \$500,000 in appropriation funds used by RTI were applied to labor costs inclusive of indirect overhead charges. See **Appendix A** for details of the expenditure of RTI state funds for this past fiscal year.

### OUTLOOK FOR STATE FISCAL YEAR 2015–2016

For the State fiscal year 2015-2016, RTI plans to continue to utilize State of NC funding to further strengthen its energy program. The funds are anticipated to be used to leverage federal funds for the following technology development projects for which RTI has received award notices and for which contract negotiations are currently under way:

- **Carbon, Hydrogen, and Separation Efficiencies in Bio-oil Conversion Pathways.** RTI will use FY 2015-2016 state funding to leverage U.S. DOE funding to demonstrate a novel catalyst technology that will reduce the overall hydrogen demand for catalytic fast pyrolysis of biomass and also a process to improve the overall carbon efficiency for biomass conversion by recovering carbon that leaves the process in a waste water stream and returning it to beneficial use in the process. This is phase 2 of a multi-year project to develop and demonstrate such advanced technology. The project will be done in collaboration with Veolia Water, a global leader in water treatment technologies with major offices in Cary, NC.
- **CO<sub>2</sub> Capture Lab and Bench Scale Sorbent Development.** The efficiency and cost of carbon capture can be improved if a solid sorbent can be developed and demonstrated that can capture carbon dioxide at elevated temperatures with low regeneration energy penalty. RTI has developed sorbent formulations that hold great promise and state funding will be used to leverage U.S. DOE funding to test the performance of these sorbents at lab and bench scales.
- **Low-Energy Water Recovery from Subsurface Brines.** RTI will use FY 2015-2016 state funding to leverage U.S. DOE funding to help provide a solution to the water management issues encountered when CO<sub>2</sub> emissions from power plants are captured and stored underground to reduce climate impact, an approach called carbon capture and storage (CCS). In these instances, impaired waters with a very high mineral content can pose a significant water treatment challenge. Under this project, RTI will develop and demonstrate at bench-scale a low-cost, low-energy water treatment process for the economical extraction of clean water from high-total dissolved solids (TDS) brines. TDS is a concentration of minerals dissolved in water

which requires treatment before the water can be used for other processes. It is expected that the project will determine the most appropriate technology for TDS removal in order to meet potable standards.

- **SSL Luminaries.** RTI will use FY 2015-2016 state funding to leverage U.S. DOE funding for long-term performance and reliability characterization of LED solid-state lighting systems to be conducted in cooperation with Cree, a prominent lighting company located in the Research Triangle Park in NC. State funds will be leveraged to complete the guidance documents and provide additional technical insights to state lighting engineers. The results of this work will aid individual, commercial, industrial, and state-funded entities in their decisions regarding the viability and utilization of these advanced lighting systems which hold great promise for reducing energy consumption and costs.
- **AutoCAMMS Methane Sensor.** RTI will use FY 2015-2016 state funding to leverage U.S. DOE funding for the development of small-footprint sensors for detection of fugitive methane emissions from oil and gas extraction wells. Such fugitive emissions are a significant concern because methane has a much greater near-term greenhouse gas impact than carbon dioxide. This project will be conducted in cooperation with Duke University.
- **Fouling-Resistant Membranes for Treating Concentrated Brines for Reuse in Advanced Energy Systems.** RTI will use FY 2015-2016 state funding to leverage U.S. DOE funding to help demonstrate a low-cost, novel water treatment process using electrically conductive membrane distillation (ECMD) for the reuse of concentrated brines. This project's goal is to demonstrate a new class of such membranes that will mitigate the fouling issues that often occur during water treatment. Anticipated benefits/outcomes of the advanced technology will include at least 50% reuse of treated water, 35% to 90+% reduction in water treatment cost, and improvement in membrane fouling relative to existing membranes. This is for phase 2 of a multi-year project to develop and demonstrate such advanced technology. RTI will be collaborating with Veolia Water, a global leader in wastewater services with major offices in Cary, NC.

In addition to supporting these already defined projects, RTI anticipates utilizing the balance of state fiscal year 2015-2016 State of NC funding to support 1-2 additional federally-funded projects that are anticipated but yet to be finally awarded.

## SUMMARY

All of the funds received by RTI have been used for the purposes for which they were granted. Financial data for all funded projects have been provided for FY 2014-2015. The line item budget for the FY 2014-2015 use of funds is attached in Appendix A. We appreciate the State's support of the above projects and the continued opportunity to hire and retain jobs in the State of North Carolina. Please direct any questions to David L. Denton, Senior Director, Business Development, Energy Technology Division, RTI International, [ddenton@rti.org](mailto:ddenton@rti.org) or 919-485-2609.



## APPENDIX A: STATE OF NORTH CAROLINA COST SHARE FUNDING, FY 2014-2015

### Summary

State of NC Funding \$500,000

| Project/Proposal   | Start Date | Total Cost   | DOE Award    | Cost Share Requirement | Use of NC Funds   | Federal Dollars Leveraged |
|--|------------|--------------|--------------|------------------------|-------------------|---------------------------|
| Carbon, Hydrogen, and Separation Efficiencies in Bio-oil Conversion Pathways   | 9/1/2014   | \$ 1,221,566 | \$ 977,253   | \$ 244,313             | \$ 213,998        | \$ 855,992                |
| SSL Luminaries Add-On  | 10/1/2014  | \$ 718,526   | \$ 574,821   | \$ 143,705             | \$ 123,705        | \$ 494,820                |
| Low CO2 Coal-to-Liquids  | 10/1/2014  | \$ 2,055,485 | \$ 1,644,388 | \$ 411,097             | \$ 110,000        | \$ 440,000                |
| Fouling-Resistant Membranes for Treating Concentrated Brines for Reuse in Advanced Energy Systems                          | 10/1/2014  | \$ 437,500   | \$ 350,000   | \$ 87,500              | \$ 39,868         | \$ 757,492                |
| Internal Combustion Engine Reformer/Converter for Gas-to-Liquids Conversion Collaboration with MIT and Columbia University | 5/28/2014  | \$ 3,500,000 | \$ 3,325,000 | \$ 175,000             | \$ 12,429         | \$ 236,151                |
| <b>TOTAL</b>   |            |              |              | <b>\$ 1,061,615</b>    | <b>\$ 500,000</b> | <b>\$ 2,784,455</b>       |
| <b>Unallocated Funding (to return to state):</b>   |            |              |              |                        | <b>\$ -</b>       |                           |
| <b>DOE- to-State Funds Leverage Ratio:</b>   |            |              |              |                        | <b>5.57</b>       |                           |

### Funding Breakout - by Project by Quarter

| <i>7/1/14 - 6/30/15 = Actuals</i>   | Q1                  | Q2                    | Q3                  | Q4                  | Total             |
|---|---------------------|-----------------------|---------------------|---------------------|-------------------|
|   | 7/1/14 -<br>9/30/14 | 10/1/14 -<br>12/31/14 | 1/1/15 -<br>3/31/15 | 4/1/15 -<br>6/30/15 |                   |
| <b>Carbon, Hydrogen, and Separation Efficiencies<br/>in Bio-oil Conversion Pathways</b> |                     |                       |                     |                     |                   |
| Labor (w/ Fringe)   | \$228               | \$ 25,920             | \$ 54,220           | \$ 100,989          | \$ 181,357        |
| Travel, Services, etc.  | \$                  | \$ 5                  | \$ 11               | \$ 11,368           | \$ 11,385         |
| Equipment, Materials, Subcontractors  | \$                  | \$ 5,493              | \$ 76,963           | \$ 9,636            | \$ 92,093         |
| Overhead (Indirect) Costs   | \$306               | \$ 34,607             | \$ 75,441           | \$ 142,010          | \$ 252,363        |
| <b>Total</b>  | <b>\$ 534</b>       | <b>\$ 66,025</b>      | <b>\$ 206,635</b>   | <b>\$ 264,003</b>   | <b>\$ 537,198</b> |
| <b>Labor (fully loaded)</b>   | <b>\$ 522</b>       | <b>\$ 59,293</b>      | <b>\$ 125,808</b>   | <b>\$ 235,390</b>   | <b>\$ 421,013</b> |
| <b>Labor (fully loaded) towards State<br/>Cost Share Funds</b>                          | <b>\$ 522</b>       | <b>\$ 59,274</b>      | <b>\$ 91,267</b>    | <b>\$ 62,935</b>    | <b>\$ 213,998</b> |

**Funding Breakout - by Project by Quarter**

| <i>7/1/14 - 6/30/15 = Actuals</i>                                 | Q1                  | Q2                    | Q3                  | Q4                  | Total             |
|---|---------------------|-----------------------|---------------------|---------------------|-------------------|
|   | 7/1/14 -<br>9/30/14 | 10/1/14 -<br>12/31/14 | 1/1/15 -<br>3/31/15 | 4/1/15 -<br>6/30/15 |                   |
| <b>SSL Luminaries Add-On</b>                                      |                     |                       |                     |                     |                   |
| Labor (w/ Fringe) \$  | -                   | \$ 69,041             | \$ 65,237           | \$ 52,560           | \$ 186,838        |
| Travel, Services, etc. \$   | 434                 | \$ 2,431              | \$ 13,443           | \$ 8,771            | \$ 25,079         |
| Equipment, Materials, Subcontractors \$                           | 447                 | \$ 1,451              | \$ 2,624            | \$ 76,444           | \$ 80,966         |
| Overhead (Indirect) Costs \$                                      | 116                 | \$ 80,881             | \$ 91,023           | \$ 70,768           | \$ 242,788        |
| <b>Total \$</b>   | <b>997</b>          | <b>\$ 153,805</b>     | <b>\$ 172,327</b>   | <b>\$ 208,543</b>   | <b>\$ 535,672</b> |
| <b>Labor (fully loaded) \$</b>                                    | <b>-</b>            | <b>\$ 147,315</b>     | <b>\$ 140,240</b>   | <b>\$ 116,560</b>   | <b>\$ 404,115</b> |
| <b>Labor (fully loaded) towards State<br/>Cost Share Funds \$</b> | <b>-</b>            | <b>\$ 93,107</b>      | <b>\$ 30,598</b>    | <b>-</b>            | <b>\$ 123,705</b> |

### Funding Breakout - by Project by Quarter

| <i>7/1/14 - 6/30/15 = Actuals</i>         | Q1                  | Q2                    | Q3                  | Q4                  | Total             |
|---|---------------------|-----------------------|---------------------|---------------------|-------------------|
|   | 7/1/14 -<br>9/30/14 | 10/1/14 -<br>12/31/14 | 1/1/15 -<br>3/31/15 | 4/1/15 -<br>6/30/15 |                   |
| <b>Low CO<sub>2</sub> Coal-to-Liquids</b> |                     |                       |                     |                     |                   |
| Labor (w/ Fringe)                         | \$ -                | \$ 12,295             | \$ 23,089           | \$ 33,157           | \$ 68,541         |
| Travel, Services, etc.                    | \$ -                | \$ -                  | \$ 5                | \$ -                | \$ 5              |
| Equipment, Materials, Subcontractors      | \$ -                | \$ 1,698              | \$ 25,358           | \$ 28,546           | \$ 55,603         |
| Overhead (Indirect) Costs                 | \$ -                | \$ 16,368             | \$ 33,009           | \$ 46,673           | \$ 96,049         |
| <b>Total</b>                              | <b>\$ -</b>         | <b>\$ 30,361</b>      | <b>\$ 81,461</b>    | <b>\$ 108,376</b>   | <b>\$ 220,198</b> |
| <b>Labor (fully loaded)</b>               | <b>\$ -</b>         | <b>\$ 28,129</b>      | <b>\$ 53,565</b>    | <b>\$ 77,284</b>    | <b>\$ 158,978</b> |
| <b>Labor (fully loaded) towards State</b> |                     |                       |                     |                     |                   |
| <b>Cost Share Funds</b>                   | <b>\$ -</b>         | <b>\$ 28,128</b>      | <b>\$ 41,944</b>    | <b>\$ 39,928</b>    | <b>\$ 110,000</b> |

### Funding Breakout - by Project by Quarter

| <i>7/1/14 - 6/30/15 = Actuals</i>  | Q1                  | Q2                    | Q3                  | Q4                  | Total      |
|--|---------------------|-----------------------|---------------------|---------------------|------------|
|  | 7/1/14 -<br>9/30/14 | 10/1/14 -<br>12/31/14 | 1/1/15 -<br>3/31/15 | 4/1/15 -<br>6/30/15 |            |
| <b>Fouling-Resistant Membranes for Treating Concentrated Brines for Reuse in Advanced Energy Systems</b> |                     |                       |                     |                     |            |
| Labor (w/ Fringe)  | \$ -                | \$ 8,171              | \$ 8,138            | \$ 22,217           | \$ 38,525  |
| Travel, Services, etc.   | \$ -                | \$ 1,290              | \$ 9                | \$ 1,574            | \$ 2,873   |
| Equipment, Materials, Subcontractors   | \$ -                | \$ -                  | \$ 11,963           | \$ 22,821           | \$ 34,784  |
| Overhead (Indirect) Costs  | \$ -                | \$ 7,434              | \$ 7,394            | \$ 24,979           | \$ 39,806  |
| <b>Total</b>   | \$ -                | \$ 16,895             | \$ 27,504           | \$ 71,590           | \$ 115,989 |
| <b>Labor (fully loaded)</b>  | \$ -                | \$ 15,211             | \$ 14,971           | \$ 45,445           | \$ 75,627  |
| <b>Labor (fully loaded) towards State Cost Share Funds</b>   | \$ -                | \$ 15,211             | \$ 14,952           | \$ 9,705            | \$ 39,868  |

### Funding Breakout - by Project by Quarter

| <i>7/1/14 - 6/30/15 = Actuals</i>   | Q1                  | Q2                    | Q3                  | Q4                  | Total             |
|---|---------------------|-----------------------|---------------------|---------------------|-------------------|
|   | 7/1/14 -<br>9/30/14 | 10/1/14 -<br>12/31/14 | 1/1/15 -<br>3/31/15 | 4/1/15 -<br>6/30/15 |                   |
| <b>Internal Combustion Engine<br/>Reformer/Converter for Gas-to-Liquids<br/>Conversion Collaboration with MIT and<br/>Columbia University</b> |                     |                       |                     |                     |                   |
| Labor (w/ Fringe)   | \$ 12,989           | \$ 35,131             | \$ 30,619           | \$ 24,163           | \$ 102,902        |
| Travel, Services, etc.  | \$ 791              | \$ 1,450              | \$ 3,261            | \$ -                | \$ 5,502          |
| Equipment, Materials, Subcontractors  | \$ -                | \$ 364                | \$ 88,504           | \$ 120,400          | \$ 209,268        |
| Overhead (Indirect) Costs   | \$ 16,323           | \$ 42,113             | \$ 43,490           | \$ 35,309           | \$ 137,235        |
| <b>Total</b>  | <b>\$ 30,103</b>    | <b>\$ 79,059</b>      | <b>\$ 165,873</b>   | <b>\$ 179,871</b>   | <b>\$ 454,906</b> |
| <b>Labor (fully loaded)</b>   | <b>\$ 28,674</b>    | <b>\$ 75,769</b>      | <b>\$ 68,800</b>    | <b>\$ 51,785</b>    | <b>\$ 225,028</b> |
| <b>Labor (fully loaded) towards State<br/>Cost Share Funds</b>  | <b>\$ -</b>         | <b>\$ -</b>           | <b>\$ -</b>         | <b>\$ 12,429</b>    | <b>\$ 12,429</b>  |